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TITLE: AN INTEGRATED STUDY OF THE GRAYBURG/SAN ANDRES RESERVOIR, FOSTER AND SOUTH COWDEN FIELDS, ECTOR COUNTY, TEXAS

Cooperative Agreement No.: DE-FC22-93BC14982

DOE/BC/14982-11

Contractor Name and Address: Laguna Petroleum Corporation, 1003 N. Big Spring, P O Box 2758, Midland, Texas, 79702

Date of Report: February 14, 1997

Award Date: August 2, 1994

Anticipated Completion Date: February 2, 1998

Government Award for Current Fiscal Year: \$649,100

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Reporting Period: Third Quarter 1996, July - September, 1996

MASTER

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ENGINEERING

During the third quarter, the Foster #11 was drilled to test the simulation and contact additional reserves in the San Andres and the Lower Grayburg. The well was located in the Southwest quarter of Section 36 to take advantage of the lack of producing wells in the West half of the Southwest quarter of the section (Fig. 1). The well is 690 feet northwest of the #4 Foster, and 690 feet southwest of the #3 Foster, 40-acre wells drilled in 1941. The #4 was plugged in 1984 and the #3 plugged in 1986. The #3 Foster was successfully reentered this year (see 1st Quarter 1996 report) and placed back on production in the A1 zone.

The Foster #11 TD'd at 4403 feet in the San Andres. A full suite of logs: Compensated Neutron, Three Detector Density, Long Spacing Sonic, Dual Lateralog, Micro-CFL, Spectral Gamma Log and Mud Log were run. Additionally, a Repeat Formation Tester was employed in an effort to obtain reservoir pressure data. Eighteen tests were attempted, with six good tests, and two formation fluid samples recovered (Table 1). The results indicate that the San Andres and the Lower Grayburg are in different pressure regimes, and the A1 Zone is depleted. Core was cut in the Lower Grayburg and San Andres to provide rock property information for these two intervals.

Based on the log calculations (Fig.2) and core recovery (Fig.3), the initial #11 Foster completion was attempted in the San Andres. The interval from 4238 feet(-1290) to 4323 feet(-1375) was perfed and acidized. Rates of 3-4 BO and 6-8 BWPD were established. Because water zones were indicated both above and below the completed interval, the fracture completion had to be designed to minimize fracturing into these zones. A "Mini Frac" was attempted with 3500 gallons cross-link gel and 6000 pounds of 100 mesh sand followed by 2000 gallons nitrified gel and 6000 pounds of sand. At the end of the quarter, the well was on test.

During this quarter, the first deepening of an existing well was completed. The Witcher #2 (Fig.1) is one of the original 40-acre wells, drilled in 1940, it was completed open hole and shot with nitro in the Upper Grayburg with TD 20 feet above the top of Lower Grayburg. The well was deepened from 4055 to 4450 feet in the San Andres. No cores were taken during the deepening of this well but a full suite of logs: Compensated Neutron, Three Detector Density, Long Spacing Sonic, Dual Lateralog, Micro-CFL, and Spectral Gamma Log and Mud Log were run (Fig.4). Located in the Northwest quarter of Section 36, the well was proposed to test the Lower Grayburg and determine if the San Andres was below the oil/water contact. The simulation results indicated untapped reserves in the Lower Grayburg at this location.

The "historic" oil/water contact of -1340 vss in the San Andres is coincident with the top of San Andres(-1334vss) at this location. There has been production in other wells deeper than -1340vss and this location was chosen to test the paradigm. Perforations from 4388(-1461vss) to 4398 feet(-1471vss) were acidized, flowed 100% water, then CIBP set. Perforations from 4291(-1364vss) to 4325 feet(-1398vss) were acidized, and the well flowed 10-12 BO and 100-120 BW. At the end of the quarter, the well was on pump, producing 33 BO, 124 BW, 8 MCFPD, having produced a total of 1380 BO and 6452 BW. This proves that the "historic" oil/water contact needs revision. It is now believed that the San Andres has multiple oil/water contacts. This will be tested in future new drills and deepenings.

Plans were made to reenter the #4 Foster-Pegues (Fig.1) and convert it to injection. This well, originally directionally drilled under the interstate, had been shut in for lack of production. The simulation indicated this location would provide Lower Grayburg pressure support for the recently completed #11 Foster-Pegues and the #10 Foster-Pegues, a Grayburg plug back completed in November, 1995.

Well testing continues, reinforcing the preliminary conclusion that the water flood, as designed and implemented, is ineffective.

The Produced Water Suspended Solids Survey, completed this quarter, found that: (a) 89% of the suspended solids are between .45 and .5 microns, (b) an injectivity enhancement chemical decreased overall suspended solids at the injection pump by 62% primarily by removing hydrocarbons from the solids, (c) the Brock and Henderson (make up water) leases contributed higher suspended solids waters to the unit, (d) a 30% increase in suspended solids occurs when incompatible waters are mixed, (e) a 65% suspended solids decrease occurs between the Gunbarrel Inlet and Gunbarrel Outlet, and (f) a further 8% suspended solids decrease occurs between the Gunbarrel Outlet and the Injection Pump Suction. The water system is, therefore, removing the majority of dissolved solids and only the Brock and Henderson leases need to be tested to see what corrective measures need to be taken. No other changes to the waterflood system surface facilities are planned at this time.

GEOLOGY

Foster #11 Core

The Foster #11 was cored in the Lower Grayburg from 4045 to 4148 feet and the San Andres cored from 4149 to 4220 feet. Note: because of a driller's error, the core depths were 45 feet off from the electric log depths. Thus, 4200 feet in the core equals 4155 feet in the electric log. Core depths referred to in this report are adjusted. The core analyses report (Fig.3), however, reflects the depths as recorded at the well site. The core has been analyzed, and thin sections cut. The core and thin sections are being described. The core analysis indicates that the lowermost Grayburg, unlike Foster-Pegues #11, is relatively tight. The San Andres core analyses from the Foster #11, are consistent with the two San Andres cores (Witcher #6, and Brock #10) taken prior to the study.

The Lower Grayburg is a series of shallowing upward cycles composed primarily of shallow subtidal to intertidal supratidal facies. The visible porosity is primarily fenestral with little if any secondary porosity. There are some small, 2-4 feet long vertical fractures with oil staining. The deepest water facies (Maximum Flooding Surface), a fusulinacean wackestone, are found within 30 feet of the transgressive base of the Grayburg. There are no reworked siliclastics at the base of the Grayburg. A number of exposure surfaces with associated minor karstification are seen in this section.

The San Andres is composed of very porous and permeable cross-bedded ooid and skeletal packstones and grainstones separated by intervals of massive anhydrite with collapsed mudstone and wackestone rubble. These anhydritic intervals are interpreted to be cavern fill sediments as they are featureless and lack the classic "chicken wire texture" of sabkha anhydrite. The terminal event of the San Andres is a major subaerial exposure surface with an associated drop in the water table of at least 60 feet at the Foster #11 location (Fig.2), and 50 feet at the Witcher #2 location (the Witcher #2 is structurally lower and basinward of the #11 Foster). During subaerial exposure, a sequence of mudstones and wackestones, originally interbedded with the grainstones and packstones, underwent intense dissolution. The aragonitic mudstones and wackestones were prone to dissolution by fresh water in the vadose environment, whereas the calcite rich grainstones and packstones were resistant and acted as cave roofs and floors. There is crackle breccia, indicative of incipient cave roof collapse, in the core near the base of the grainstone at 4198 feet (4153 on logs) above one of the anhydrite infill intervals.

Foster #11 Logs

It is very difficult to make log correlations within the San Andres. There are no area-wide correlation in the upper 50 feet of the San Andres. From the core/log relationships, the interval ranges from 100% anhydrite; to 50% wackestone/ mudstone or anhydrite and 50% grainstone/packstone; to almost 100% grainstone/packstone (Fig.5). Beginning 50 to 75 feet below the top of the San Andres, and extending down at least 150 feet, there appear to be a series of 30 to 70 feet thick shallowing upward sequences, which shallow into thick, highly porous units (interpreted to be grainstone shoals), capped by less porous units (interpreted to be lower energy packstone/wackestone). These units are identified by porosity log signature as there is little gamma log character. When these facies were plotted on a map of seismic reflection amplitudes at the top of the San Andres, a good correlation was seen. Anhydrite-rich log character is correlated with low reflection amplitude, and grainstone/packstone (>8% porosity) log character with high reflection amplitude.

Witcher #2

The Witcher #2 was completed flowing from acidized perfs in the upper 60 feet of the San Andres in an area with high reflection amplitude. Based on log character (Fig.4), the upper 21 feet of the San Andres is composed of a 2 feet thick massive anhydrite, an 11 feet thick shale rich cave infill and a 7 feet thick massive anhydrite, above a porous (16% cross-plot porosity) interval with possible fractures (crackle breccia?). At the base of the porous unit, and just above the interpreted water table, is another anhydrite interval. As in the Foster #11, the porous interval is believed to be calcite rich grainstone/packstone. This diagenetic overprint on the uppermost San Andres has a major impact on reservoir distribution and behavior. Without a proper understanding of this diagenetic history, successful completions in the San Andres are "hit or miss".

Water Saturations

Water saturations (Sw's) for the San Andres, in the Foster #11 (Fig.2), calculated using neutron/density cross-plot porosity appear to be too optimistic (9-20% Sw) when compared with visual inspection of the core and the production history of other wells in the area. When water saturations for the same interval are calculated using sonic porosity, some zones calculate to have higher, and more realistic, saturations (34 -46% Sw), while other zones calculate "wet" (50 - 100% Sw). When two zones with cross-plot porosities of 14-18% and low Sw's (calculated by both methods) were

perforated and acidized, pumping production rates of only 4-5 BO and 6-8 BWPD were obtained.

A possible explanation for this is found in the porosity/permeability cross-plots of the core data. Although many analyzed intervals have permeabilities of >1 Md for porosities of 14-18%, other highly porous zones have permeabilities of $<<1$ Md. A comparison of the cross-plot neutron/density porosity (which match well with the core analyses), to the sonic porosity is revealing. There appears to be 8 to 10% secondary porosity above the sonic porosity (Fig. 2). Zones with up to 18% total porosity, may have only 5 to 7% sonic porosity and low permeabilities (<1 md). This observation, coupled with the production test results, indicate that there is a dual porosity system in the San Andres. One system is porous but not very permeable (vuggy) and the other permeable and porous (interparticle connected). At the end of the quarter, the San Andres had been fractured and was being tested (see Engineering).

The Witcher #2 was deepened from the Upper Grayburg through the Lower Grayburg and the San Andres to contact reservoir not previously productive at this area. Again, as in the Foster #11, Sw calculations using neutron-density cross-plot porosities are overly optimistic (Fig.4). Water saturations calculated using sonic porosities were more variable and more realistic. A lower zone, 4388-4398 feet, was perfed and acidized based on fair mud log shows and marginal cross plot water saturations(16-45%). This zone flowed 100% water, confirming the sonic derived water saturations (55-100%) were correct. The zone from 4290 to 4315 feet had cross plot porosities of 9-13% and sonic derived water saturations of from 12 to 45%. To date, it has produced 1380 BO and 6452 BW. There appears to be the dual porosity system present in this interval, as the water production initially dropped at a faster rate than the oil production. More recently, the oil production has begun to decline at a more rapid rate than the water. Testing of this well will continue in the 4th quarter.

Foster #11.

Seismic Project Status

The project underwent a change of geophysical interpreters in July, 1996. William C. Robinson, geophysical consultant of Midland, Texas, joined the project.

The seismic project is now being analyzed using the Vest 3DSEIS interpretation system. This software is most appropriate for stratigraphic

interpretation of seismic data because the tools available uniquely fill the criteria of being economically available to independent oil companies and individuals. Supplementing the Vest system is the PC-based mapping and display software SURFER version 6.x by Golden Software. This program is used to create superior quality maps of any geological and geophysical parameter and provides complete base map capabilities.

In July, the project status was reviewed in order to determine steps to be taken for data integration and observation. The first step was to review the seismic data to determine its characteristics of bandwidth and phase. Using the Fourier analysis built into 3DSEIS, the bandwidth of the migrated stack data volume was determined to be sharply limited between 20-80Hz. Because the vibroseis sweep was 10-110Hz, the data process sequence was reviewed. Although the processes were appropriate and adequate, one insidious parameter within the surface-consistent deconvolution step had indeed bandlimited the data initially to 20-80Hz. Because tests indicated that the excluded amplitudes could not be recovered by additional spectral balancing of the migrated data, the existing process sequence was re-run by Dawson Geophysical, except for the first decon routine. The resulting data volume now contains a full-bandwidth wavelet which maximizes resolution within the survey volume, as a comparison of examples of both data sets indicates (Fig.6). The data band width is shown in Fig.6A.

Experience with seismic projects of this size leads to skepticism concerning the subsurface imaging ability of seismic data "near" the survey edge. Variables such as shoot geometry, fold, processing limitations, and objective depth affect the credibility of structure, reflection amplitude, and reflection shape. Credibility of near-edge data must be judged by relative appearance, ties to well data, and reasonable risk assessment. Because this 3D survey is really very small, the data credibility must be continually considered. The data quality must be considered in the pre-migration, pre-FXY decon form in order to have a realistic view of quality. The half section eastern part of this survey is very noisy and is of limited stratigraphic value, although it is valuable for structural interpretation.

A balanced, wide-band spectrum is paramount to optimizing resolution, specifically wavelet width, and that a re-balancing process is to be applied initially and again after each signal-to-noise enhancing operation (i.e., stacking, migration). Interpretable bandwidth is a function of the signal-to-noise ratio of the objective reflection horizon and varies laterally, with depth, and with reflection strength.

Data phase was determined by reflection comparison at well tie locations with synthetic seismograms made using available sonic log digits (Fig.7) to this document. Digital log files of several formats were standardized to the GMA binary format, for forward model studies. In some cases, the log curves were edited. Each log was also converted to a Vest-readable format, to be used in direct phase comparison. These comparisons agreed with the initial evaluation that the data from the processor have a 90 degree phase lead; thus, the data volume was phase shifted, using the Vest phase shift routine, to produce a new data volume of zero phase data which has been used in all subsequent work.

Synthetic seismograms were incorporated into a cross section and then a 2D forward model was created to show ties of log correlations with seismic (and synthetic) reflections and demonstrate visual changes across the interpolation model. The results of this and other models are discussed later.

Familiarization with the Project

A learning curve of project familiarization included project location, various data available, existing previous work, association with team members and equipment, and project objectives. Early discussions took place with Mr. Jim Sandell, Mr. Bob Trentham and Mr. Dick Weinbrandt, exposing their study objectives of relating geology and waterflood program characteristics and their interest in the ability of the seismic data to detail those relationships between well control points. Examples of topics discussed were 1) relating the resolution of seismic reflection intervals compared to log fine-sequence resolution, 2) very preliminary map observations statistically compared to interval porosity measurements and a test of the mechanical interface between geophysical and engineering computer software packages, 3) data resolution optimization, and 4) project plans and timing. Preliminary correlations were made for seismic reflections, simple and complex geometries of the Grayburg and San Andres were debated, and an approximate vertical resolution of the seismic wavelet was estimated at 100 feet. The results of previous seismic interpretation and mapping supplied a minimal starting point.

An early and premature exercise was to compare the preliminary Grayburg reflection instantaneous frequency with Grayburg A1 zone average porosity, established from porosity-type log measurements. The result was colorful, anomalous, and interesting (although weakly related) but served to test the compatibility of seismic and well derived data files with the engineering software.

Planning

The objective at the early stage of any project is to make many observations efficaciously, creating profiles, cross sections, and maps. Deeper, time-consuming evaluations come later, once a degree of understanding and priority is established. Priority of time limits our current study to the Grayburg and San Andres formations.

A list of logical maps of seismic reflections was established, including the Yates, Queen, Grayburg, San Andres, and some event below the San Andres. These reflections were subsequently tracked on the seismic data and were mapped as surfaces of time structure, isochrons, and reflection amplitude. Subsurface data from the spreadsheet were used to generate a series of contoured structure and isopach maps to be compared to the time maps.

Seismic inversion modeling will be conducted as stratigraphic analyses on an inversion model data set has a higher degree of correlation than on seismic reflection (wiggle) data. The mapped parameters of inversion data will simply be more geologically intuitive and lead to valuable conclusions more quickly. Consideration has been given to the constraint horizons to be used in calculating the model(s), as a deeper understanding of the geology and seismic relationships need to be established first. Inversion modeling is not a trivial operation only because the input parameters must be well understood, complete, and be appropriate. The mechanics of inversion are simple and the process runs fairly quickly.

Geological Orientation

Following the initial meetings, Bill Robinson visited with project personnel to discuss the geology in general, review well data, and discuss well cores for the Foster-Pegues #11 and the Foster #11. This orientation with the laid out cores was of great benefit. Two dip-oriented cross sections (L and M, not copied here due to extreme size) were constructed using spreadsheet log calls to demonstrate sequence characteristics directly compared to coincident seismic data profiles. Normal scale (10 inches/second) seismic profiles show shallow and deep structural relationships and the same profiles, partially enlarged to 40 inches/second vertical scale ("zoomed" in) show details of the Grayburg/San Andres reflections. A companion cross section of synthetic seismograms enlarged to well log scale (2.5"/100') helps to visualize vertical resolution relationships. A 2D forward interpolation model of the synthetic seismograms across the Grayburg sequence demonstrates expected seismic changes across section L-L¹. Notably, the

reflection tracked as the top of the Grayburg, is associated with the A1 correlation in the west part of the study area, but ties to a carbonate unit within the Lower Queen (well separated from the A1) in the east part of the 3D. Seismic profile L-L¹ (Fig.8) duplicates the well log cross section map trace, showing the seismic sequence from the Queen formation downward to the Pennsylvanian. Three strike-oriented seismic profiles have been displayed, but well log cross sections have not yet been made to match them.

A strong amplitude anomaly exists on the map of the amplitude of the reflection about the top of the "San Andres" relating to the amount of porosity (within 100 feet of the San Andres surface) in wells. The reflection "San Andres" may only approximate the correlation boundary. The relationship compelled investigation as a useful indicator of porosity distribution. The initial reaction (from general experience) was that the existence of porosity near the top of San Andres should result in a *weaker* reflection amplitude. Utilizing the recent cores, Trentham points out that there are no strong lithologic changes separating the Grayburg from the San Andres, so that only a weak San Andres reflection should normally exist. The reflectivity should increase with the only likely seismic (velocity) parameter change within the geological spectrum: with good porosity development. A forward model was made to test the effects of various amounts of upper San Andres porosity on seismic reflectivity, and the result compared well with the observed strong amplitude of the seismic profiles.

Mapping

Base map construction was accomplished by editing existing CAD-type digital files for use in SURFER. A spreadsheet, recording surveyed well locations and well top data, was printed. This base map will serve as a common base for all subsequent maps of geology and geophysics, and can be updated easily by modifying the well data spreadsheet and by adding or removing map layers. It can also be imported into the SSI Workbench for integration into the reservoir model.

The first series of maps discussed above included subsurface and seismic reflection maps of main correlation horizons. All Grayburg internal correlations (log calls) will be mapped along with isopach intervals, both for quality control and for their information value. Seismic reflections from near the tops of Grayburg (Fig.9) and San Andres (Fig.10) are mapped, showing the features of the relatively flat shelf area in the west and the structural break to the outer shelf in the east. The position of cross section L-L¹ is shown on the maps.

Reflections from below the San Andres (Pennsylvanian, Devonian) were tracked to relate buried structure and (perhaps) faulting to structural boundaries observed in the Grayburg sequence. Seismic faults were tracked, but rigorous relationships could not be easily demonstrated; the horizon interpretations are ready to be evaluated.

Near-term Objectives

Resolution of the seismic data is being studied to further relate the seismic scale to the geologic (log) scale for the Grayburg and the San Andres formations. Additional simplified forward models will be built to demonstrate the effects on seismic response of porosity changes within several levels of the Grayburg sequence. Thought has been given to the maximum economically achievable seismic resolution, for the sake of some future 3D or specific-task 2D seismic acquisition, and has been included in model studies.

Quantities of subsurface maps will be made and revisions will be made to some of the preliminary seismic correlations, requiring remapping. Inversion modeling will be moved forward. New maps of seismic intervals will be made using interval averaging and slicing methods.

Geophysical Conclusions

The most interesting observation so far is the strong relationship of San Andres stronger amplitude with good porosity in some wells and of weaker amplitude with non-porous, anhydrite rich, San Andres in other wells. The observation has immediate economic interest since deepening of certain Grayburg wells to the San Andres would be justified and encouraged, while other might be postponed or dropped from the program. Forward models made so far support seismic interpretations of observations and define the vertical scale of seismic resolution (lateral resolution will also be addressed). The continuous reflection labeled Grayburg, actually crosses time-stratigraphic lines, as do other reflections.

References

A statistical comparison of well log-defined geologic characteristics with observable seismic attributes is found in the three-part article, "Seismic-guided estimation of log properties" by Schultz, Ronen, Hattori, and Corbett was published in the May-July, 1994, *SEG The Leading Edge*.

The University Lands/Bureau of Economic Geology (BEG) group seminar (11/6/96) provided a methodology for relating fine cycle sedimentation

packages as described in the South Cowden field to the seismic sequence and tied to the right position by log points. Looking for recognized geometries of tidal channels and bars or banks, which strongly affect internal permeability of production flow will be an objective. Also, map anomalies in the Lower Queen interval might be directly related to Upper Grayburg stratigraphy. Project personnel plan to contact BEG scientists to obtain applicable data from the South Cowden project.

A review was undertaken of articles by Reeves and Smith presented at the WTGS November, 1994, Midland Symposium and at the February, 1996, 3D Seismic Symposium in Denver, as well as project files. Project personnel have also reviewed the September, 1996, technical report of the OXY/DOE Welch Unit project and will use some of the methods described therein as a template for evaluation of aspects of this project.

Tech Transfer

An abstract for the Poster Session at the fourth International Reservoir Characterization Technical Conference March 2-4, 1997, was submitted.

Acknowledgements

We would like to acknowledge James J. Reeves and Hoxie W. Smith for conceiving and managing the DOE study and for being responsible for the geophysical study. We would also like to acknowledge that since April, 1996, William C. Robinson has been responsible for reprocessing and reinterpreting the seismic data and for the geophysical study. Also since that date, Robert C. Trentham has been responsible for project management.

DEPTH	ZONE	FORMATION PRESSURE	HYDROSTATIC PRESSURE
3577.1	A-1	124.5	2087.9
4038.0	D	2070.0	2246.0
4081.0	F	2142.0	2271.1
4301.0	SADR	2161.3	2394.5
4339.0	SADR	2191.2	2415.5

Table 1. Repeat Formation Tester Pressures

FIG. 2 - LOG CALCULATIONS FOR SAN ANDRES SECTION OF FOSTER #11 SHOWING GAMMA RAY; NEUTRON-DENSITY CROSS PLOT POROSITY AND SONIC POROSITY; WATER SATURATION CALCULATED USING CROSS PLOT AND SONIC POROSITY AND DIFFERENCE BETWEEN CROSS PLOT AND SONIC DERIVED POROSITY AND WATER SATURATIONS

RESERVOIRS, INCORPORATED.

COMPANY: LAGUNA PETROLEUM
WELL: H.C. FOSTER #11
FIELD:
COUNTY: ECTOR
LOCATION:
API NO.:

STATE: TEXAS

FORMATION: GRAYBERG
CORING FLUID:

FILE NO.: RMC338
DATE: 7-20-96
ELEV.:
CORED BY: DOMOCO
ANALYST: DAVID FLOYD

FIG. 3 - CORE REPORT FOR FOSTER #11

FIG. 4 - LOG CALCULATIONS FOR SAN ANDRES SECTION OF WITCHER #2 SHOWING GAMMA RAY; NEUTRON-DENSITY CROSS PLOT POROSITY AND SONIC POROSITY; WATER SATURATION CALCULATED USING CROSS PLOT AND SONIC POROSITY AND DIFFERENCE BETWEEN CROSS PLOT AND SONIC DERIVED POROSITY AND WATER SATURATIONS

FIG. 5 - FACIES DISTRIBUTION FOR UPPER 50 FEET OF SAN ANDRES

FIG. 6 - COMPARISON OF MIGRATED STAK DATA,
1995 PROCESSING VS. 1996 PROCESSING
SYNTHETIC SEISMOGRAM OVERLAY ON RIGHT

FIG. 6A - AMPLITUDE SPECTRUM OF DATA SET WITH EXAMPLE OF DATA (TRACE 25)

FIG. 7 - DATA AS PROCESSED WERE PHASE SHIFTED 90° TO TIE ZERO PHASE SYNTHETIC SEISMOGRAMS. SENSITIVITY OF VISUAL RELATIONSHIPS IS SHOWN IN THE 45° EXAMPLES.

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FIG. 8 - USER TRACK TIED TO AVAILABLE SONICS