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Seismic and Well Log Evaluation

(Topical Report)

Characterization and Quantification of the Methane Hydrate Resource Potential Associated with the Barrow Gas Fields

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Topical Report:

Seismic and Well Log Evaluation of the Barrow High Area, Including the Walakpa and Barrow Gas Fields

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CHARACTERIZATION AND QUANTIFICATION OF THE METHANE HYDRATE RESOURCE POTENTIAL ASSOCIATED WITH THE BARROW GAS FIELDS

DOE Project Number: DE-FC26-06NT42962

Awarded to

North Slope Borough, Alaska

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EXECUTIVE SUMMARY

This Topical Report details the seismic interpretation, well log analysis, and mapping that has been undertaken in support of the Barrow gas hydrates study. Available seismic lines were matched in phase and timing and tied to well control. A set of regionally mappable and geologically significant seismic horizons were selected and interpreted throughout the area in order to tie together the various field areas and update the regional structural interpretation. Available well logs were correlated, and updated picks corresponding to the seismic horizons were utilized in constructing depth maps. The well logs were analyzed to calculate reservoir properties. Mapping work was undertaken on both a regional basis and individually for the Walakpa and Barrow gas fields.

The Walakpa Sandstone appears to be widely distributed and is present at depths corresponding to the modeled gas hydrate stability zone over a large area. Well log correlation updip of the Walakpa Gas Field indicates that the sands continue to the crest of the Barrow Arch, and log analysis indicates that the Walakpa Sandstone is hydrate-bearing updip of the Walakpa #1 well. In fact, the Walakpa #1 well itself appears to be hydrate-bearing, based on test results and log characteristics.

The Barrow sandstone unit appears to have been drilled on its structural crest within the East Barrow Field, and hydrates are interpreted to be present within the Upper and Lower Barrow Sandstone intervals in this crestal location, based on hydrate stability zone modeling, and log characteristics.

INTRODUCTION

Updated seismic mapping work was undertaken across the Barrow High area, including 1) the Barrow Gas Fields, in which the Jurassic Barrow sandstone is the primary reservoir unit, and 2) the Walakpa Gas Field, which produces from a Neocomian sandstone that was deposited on the Lower Cretaceous Unconformity (LCU) surface. A depth structure map on the LCU was produced for the entire region, and a sub-regional depth structure map on the top of the Barrow sandstone was produced covering the East Barrow, South Barrow, and Sikulik field areas. In addition, individual field maps were produced for all four fields, as shown in Figure 1.

All available well data files and reports were reviewed and incorporated into the interpretation, and an updated well pick data set was created from log correlation work. The well picks were used as control for the depth conversion of corresponding seismic horizons and for the generation of isochore maps. Structure and thickness grids, together with the well picks that resulted from this study, were used to build the framework for subsequent gas and methane hydrate reservoir modeling work within and near the field areas.

Careful tying of the seismic data with existing well control, incorporation of all available seismic lines, and phase and time matching of seismic data sets has resulted in improved structural maps for the region. Detailed stratigraphic interpretation of the key reservoir intervals through seismic modeling and attribute work has not been undertaken to date, due to the limited and inconsistent quality of available seismic data. Seismic isochore mapping of the HRZ to LCU interval was undertaken and may provide some insight into the distribution of Walakpa sandstone to the north and east of the existing Walakpa Field area.

All well log data was incorporated in a petrophysical analysis to support reservoir characterization of the Barrow and Walakpa Sandstones. Qualitative analysis of the wireline data was also undertaken to seek evidence of hydrate saturation in updip wells. A total of 26 wells were included in the petrophysical analysis, with 15 wells in the South and East Barrow Gas Field and Sikulik areas, and 11 wells in the Walakpa area.

SEISMIC DATASET

Seismic data for the study were available from two main sources: 1) the USGS and 2) the North Slope Borough(NSB). The USGS maintains an archive of over 12,000 line miles of dynamite seismic data recorded within NPR-A during the years 1972-1979. These lines are available for download from the USGS web site. In addition, the NSB acquired high resolution proprietary Vibroseis data over the Walakpa, South Barrow, and Sikulik areas during the winter of 1988-1989. Figure 1 is a map showing the total seismic line coverage used for this study.

The NSB 1988-1989 Vibroseis lines are of high quality and broad bandwidth in most areas. However, where these lines cross large lakes there is commonly a severe to complete loss of data quality. The areas most affected by data loss are the southeast quadrant of the Walakpa survey area and the area between the South Barrow and Sikulik fields. Figure 2 is an example Walakpa seismic line showing data loss where the line crosses lakes. In the South Barrow field area there is an almost total loss of reflectivity on all seven of the north-south oriented seismic lines extending south from the field.

The USGS dynamite lines vary dramatically in quality depending on the particular year and area in which they were recorded. The more regional nature of the grid allowed for positioning so that most lines do not cross large lakes. However, where these lines traverse coastal bay and lagoon areas the quality becomes poor to unusable. The 1978-1979 lines provide the best quality, and the 1972-1974 lines are the poorest. Final stacked and migrated sections for the 1972 and 1974 lines were not available for download from the USGS web site. For these lines, scanned images were downloaded from the USGS and sent to Fugro Data Solutions in Houston, TX for digital conversion to SEG-Y format.

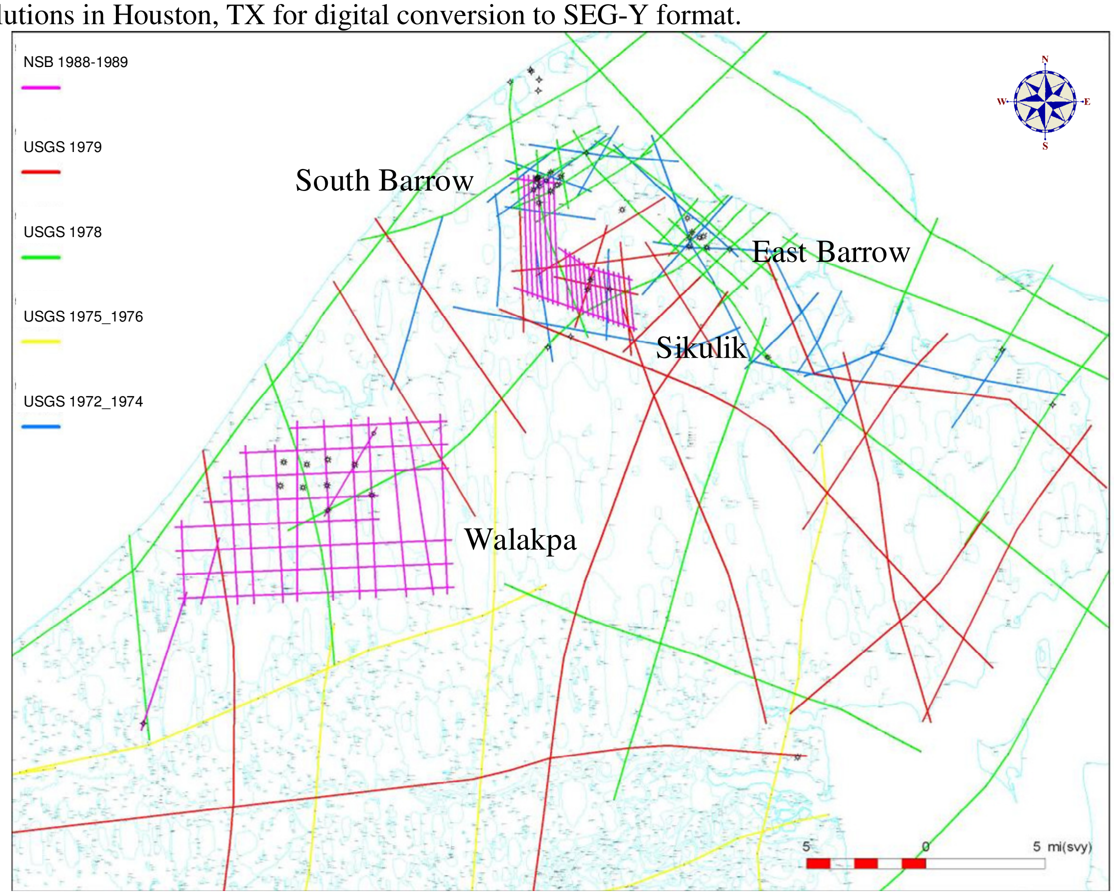

Figure1: 2D seismic data used for this study.

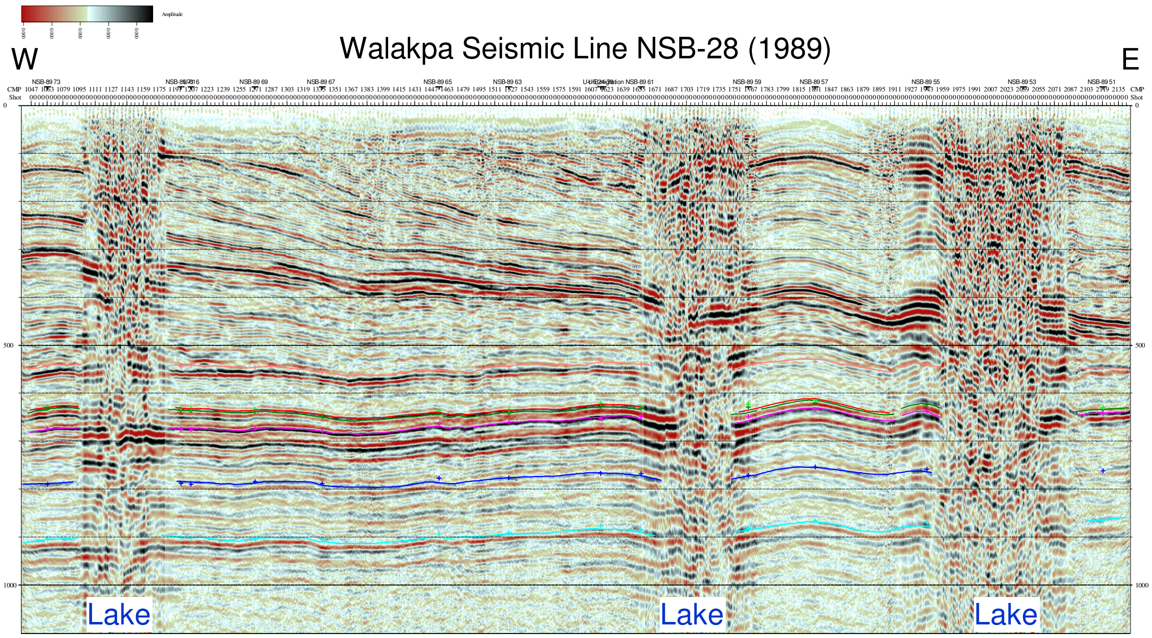

Figure 2: Example of data loss where a 1989 Walakpa Vibroseis line crosses lakes.

The total amount of data recorded by the NSB in the Walakpa area is approximately 168 line miles, and in the South Barrow and Sikulik areas the total is approximately 90 line miles. All of these data were interpreted as part of the current study. In addition, approximately 1,300 line miles of the USGS regional data were interpreted.

Following the loading of all NSB seismic lines and most USGS data to a Geographix interpretation project, constant phase rotations and time shifts were determined for the USGS lines, using the Walakpa NSB lines as control. Examples of matches between Walakpa and USGS seismic lines are shown in Figures 3 and 4.

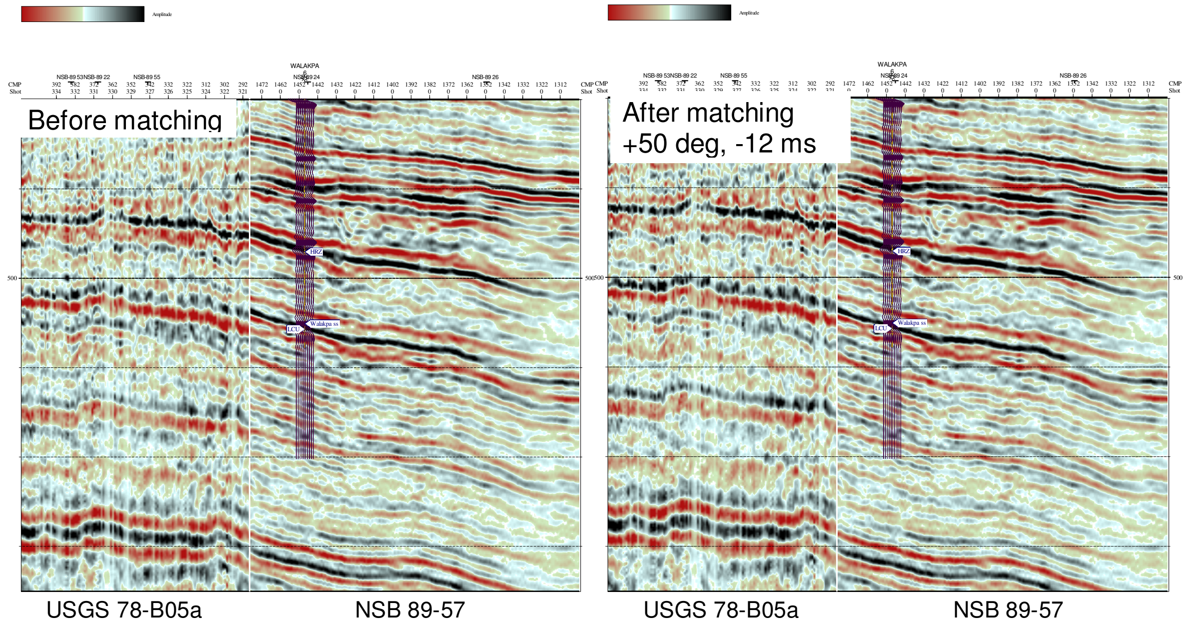

Figure 3: Before and after example of matching a USGS 1978 seismic line to the NSB Walakpa data

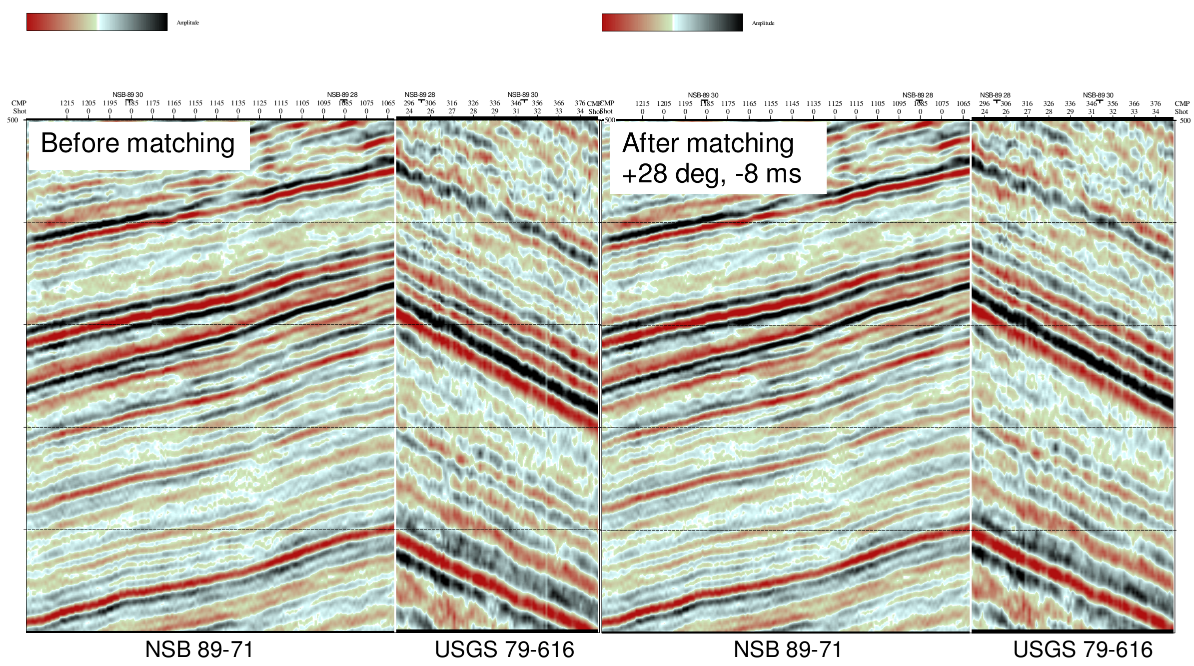

Figure 4: Before and after example of matching a USGS 1979 seismic line to the Walakpa data

The USGS lines have a dominant frequency that is much lower than the broadband Walakpa data, so a perfect character match between the data sets could not be achieved. However, matching through constant phase rotations and time shifts has allowed for better and more confident tying of interpreted horizons throughout the map area. The USGS lines that were matched to the Walakpa NSB lines were used as control for phase matching additional USGS data across the region. At first it was assumed that the lines would fall naturally into consistent sets based on vintage and naming convention. While generally true, there were significant exceptions within the 1978 and 1979 series lines. An example is shown in Figure 5. Lines 79-664 and 79-659w were found to be reversed in polarity relative to most other lines recorded in 1979. Line 78-B23 required a significantly different phase shift than line 78-05a (Figure 3).

The horizon misties were significantly reduced as a result of this effort, with few exceeding 10 ms after applying phase and time shifts.

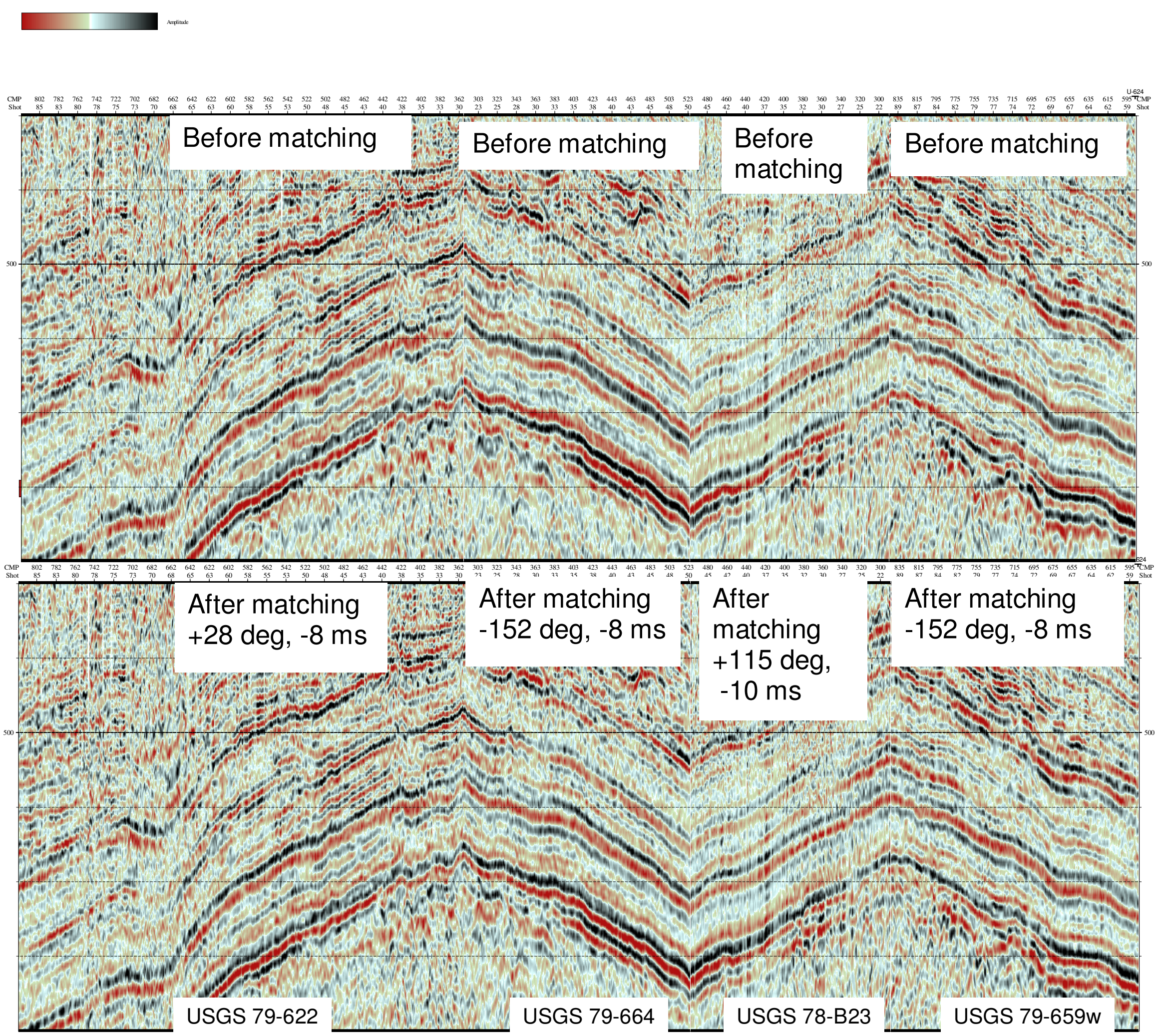

Figure 5: Phase and time matching of 1978 and 1979 USGS seismic lines

For the 1972 and 1974 USGS data sets correlation coefficients both within the sets and to other lines were extremely low. No confident phase shifts could be determined for these lines, so corrections were limited to time shifts only.

WELL TO SEISMIC TIES

Following the seismic data loading and phase correction work seismic lines were tied to wells using synthetic seismograms. Figure 6 shows the wells for which velocity (checkshot) surveys were available (red) and the wells for which synthetic seismograms were constructed (green).

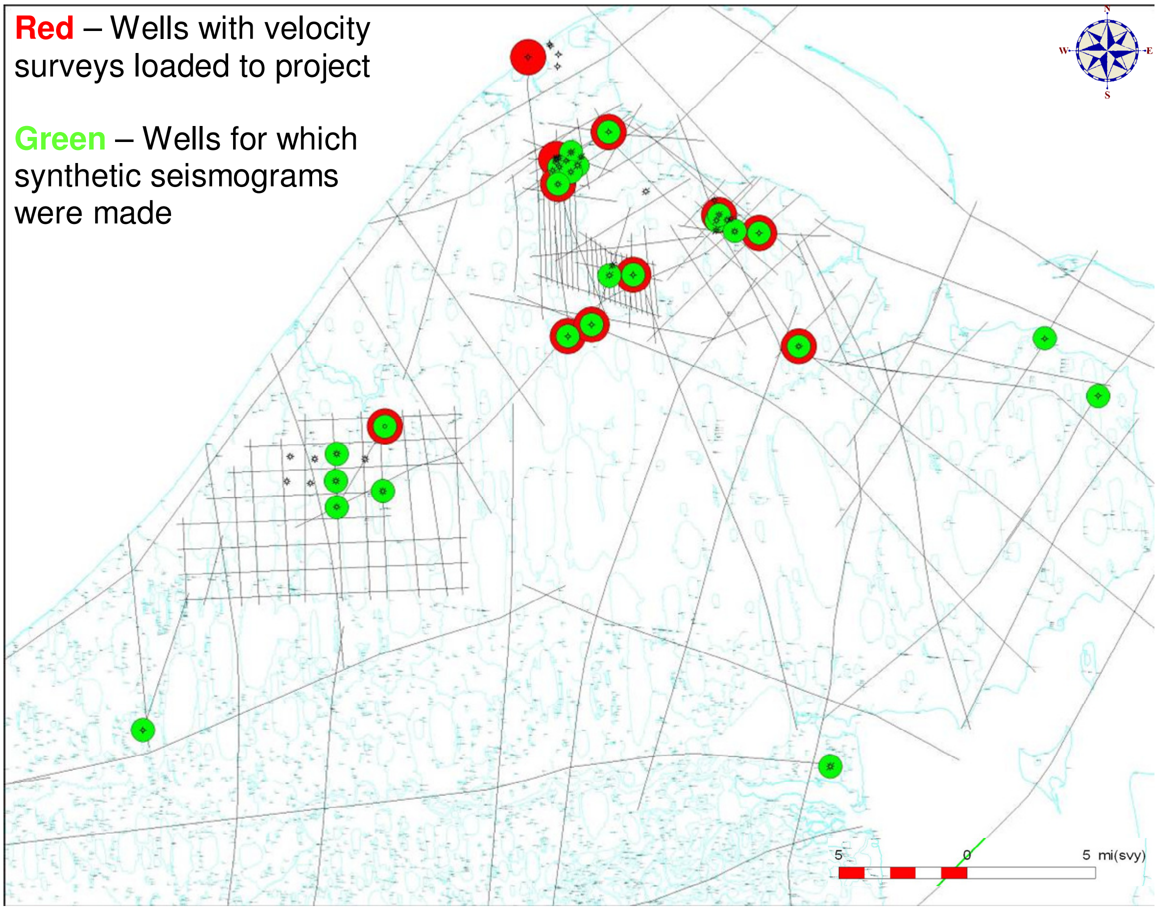

Figure 6: Wells with velocity control and synthetic seismograms

Sonic and density log quality and available depth ranges varied greatly from well to well, as did the quality of the seismic data being matched. Minor log editing was performed where logs overlapped casing strings or contained significant zones of cycle skipping; however, no attempt was made to match seismic data perfectly through log edits and supplemental adjustments to check shot times. In most cases only a time shift was applied, either through direct application or through an adjustment to the replacement velocity.

Figure 7 shows several examples of synthetic seismogram matches in the Walakpa area. In all cases a zero phase wavelet was utilized, and for the resulting synthetic seismograms a downward increase in acoustic impedance is represented by a positive number and displayed as a deflection to the right (black peak). In the seismic section display black represents a positive number and red represents a negative number.

For well ties to the 1989 NSB seismic lines a zero phase extracted wavelet was utilized in order to best match the frequency content of these data. This wavelet is shown in Figure 8. For the USGS seismic lines a Ricker spectrum matched the data best. In most cases either a 25 Hz or a 30 HZ Ricker wavelet was utilized.

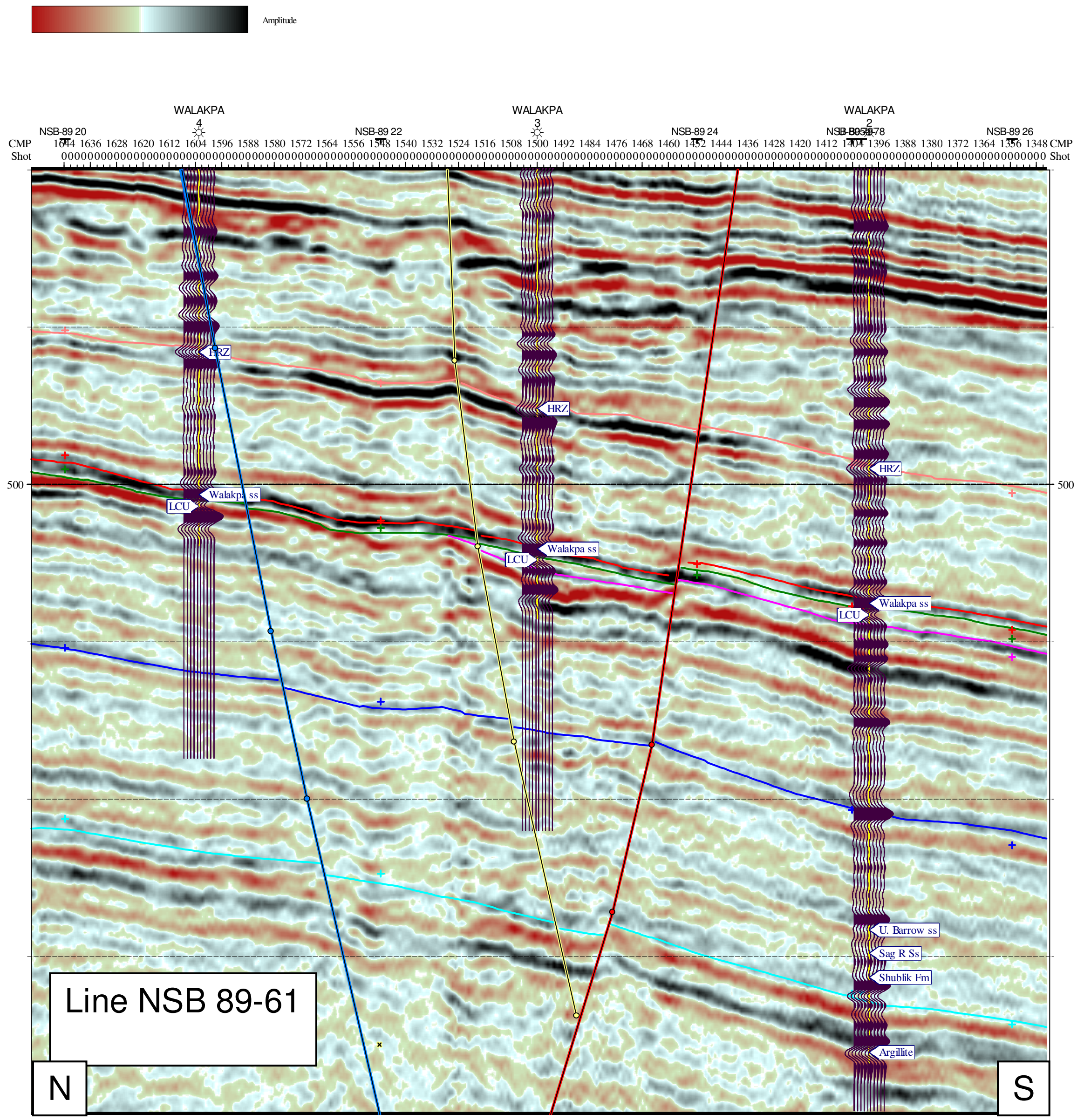

Figure 7: Example synthetic seismogram matches in the Walakpa area

Synthetic seismograms were compared both visually and through cross-correlations to the closest tie points on the seismic lines. No additional phase rotation was applied to the seismic data as a result of the comparisons. The data appear reasonably close to zero phase as currently loaded and corrected. This assumption may be revisited if detailed modeling work is performed at a later time.

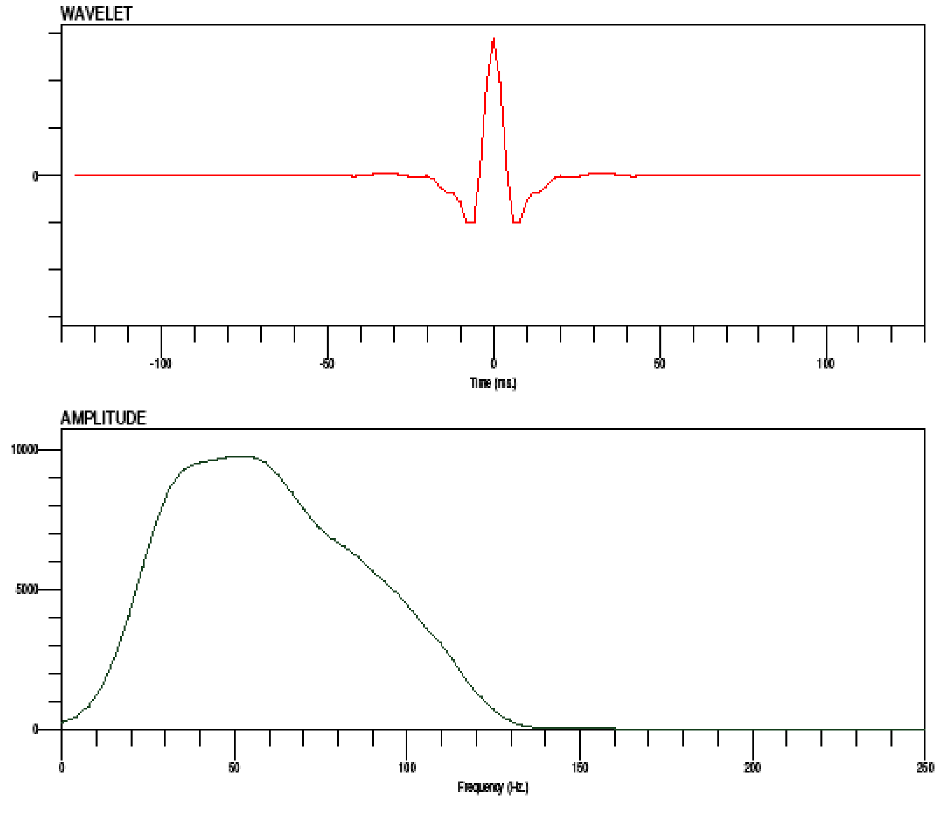

Figure 8: Wavelet used for ties to the 1989 NSB seismic lines

An additional aspect of the well interpretation work was the need to establish a consistent set of log picks for depth converting the seismic data. Figures 9 and 10 are structural cross-section displays showing revised picks for the Walakpa and East Barrow field areas.

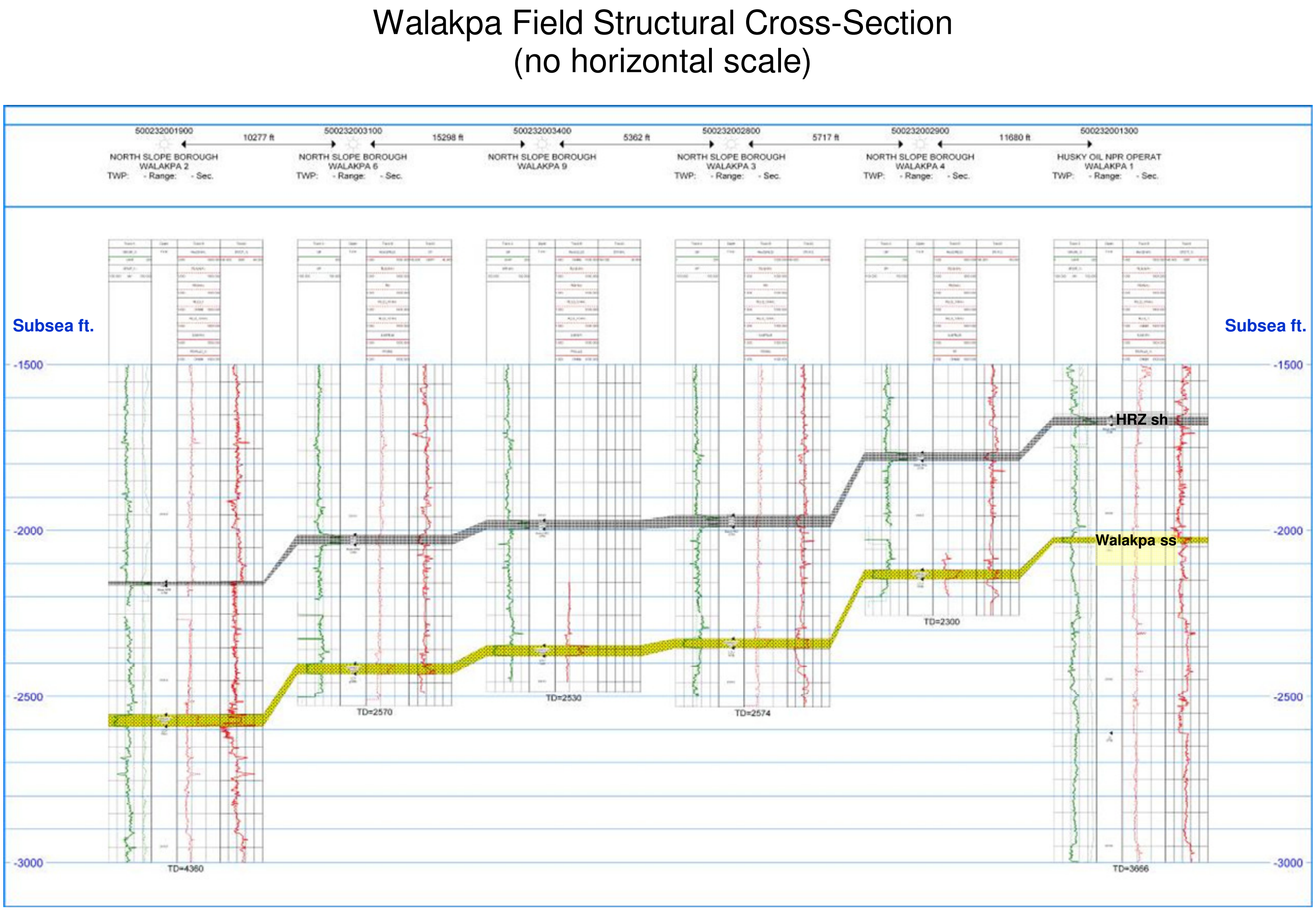

Figure 9: Structural cross-section for the Walakpa Field

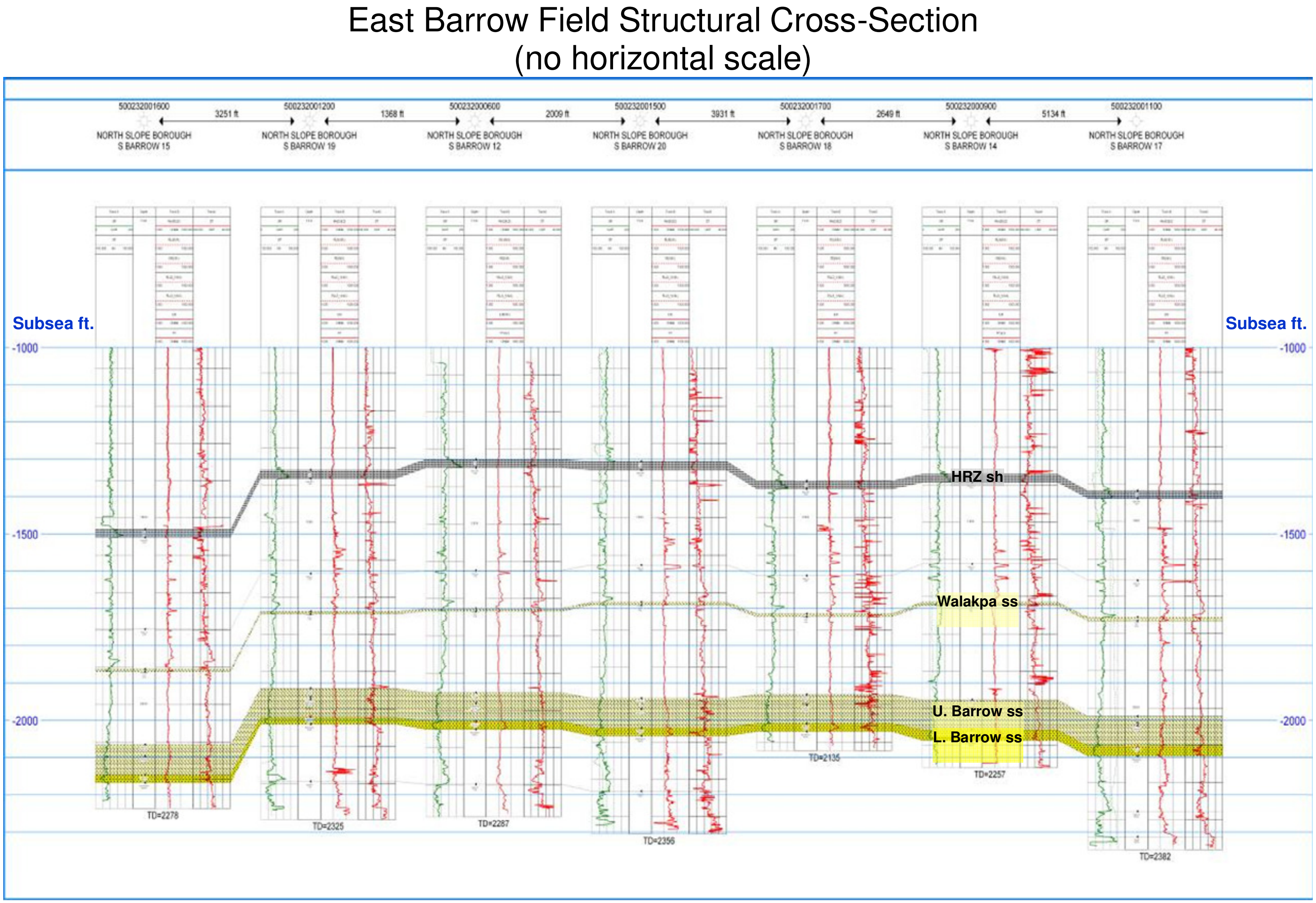

Figure 10: Structural cross-section for the East Barrow Field

It was particularly important to establish top and base picks for the Walakpa sandstone member in the Walakpa field area and for the Upper and Lower Barrow sandstone members in the East Barrow field. The previous pick database had been established from multiple sources such as well completion reports, engineering reports, and other published studies. These picks were inconsistent from well to well, particularly for the Barrow sandstone members. As part of the current study all well log picks were reviewed and reinterpreted using available correlation logs.

INTERPRETATION

Seismic interpretation work was undertaken on both regional and local field scales. The regional work covered all of the onshore area shown in Figure 1 and was undertaken for two main purposes: 1) to assure that the interpretations in the separate field areas were consistent and 2) to identify areas outside the field limits where Walakpa and/or Barrow sandstone members might be present at depths consistent with methane hydrate occurrence. Local field mapping focused on currently producing reservoir units and was done in more detail than the regional work.

The key regional horizons are shown in Figure 11 and described below:

Top HRZ – This is the youngest horizon interpreted and is associated with the top of a "highly radioactive shale" which, together with the underlying pebble shale, forms the lowest unit of the Brookian succession.

LCU – The Lower Cretaceous Unconformity is a regional surface of erosion and angular truncation. The Walakpa sandstone immediately overlies this surface.

UJ – This is an Upper Jurassic marker horizon that is truncated by the LCU in the Walakpa field area. It is important because of its subcrop amplitude effects on the Walakpa sandstone response.

LJ – This is a Lower Jurassic marker horizon which typically overlies the Barrow sandstone horizon by one or two legs (cycles). The Barrow sandstone is not an acoustically strong event in the area.

Top Shublik – The top of the Shublik Fm. Is one or two cycles below the Barrow sandstone event and provides a high quality deep marker bed for the area.

Two additional horizons were mapped locally across the field areas:

Top Walakpa Sandstone - The top of the Walakpa sandstone was picked within the 1989 NSB seismic grid covering the Walakpa field area. In this area the top of the sandstone is expressed as a peak, and the base (LCU) is near the next trough below this peak (Figure 13).

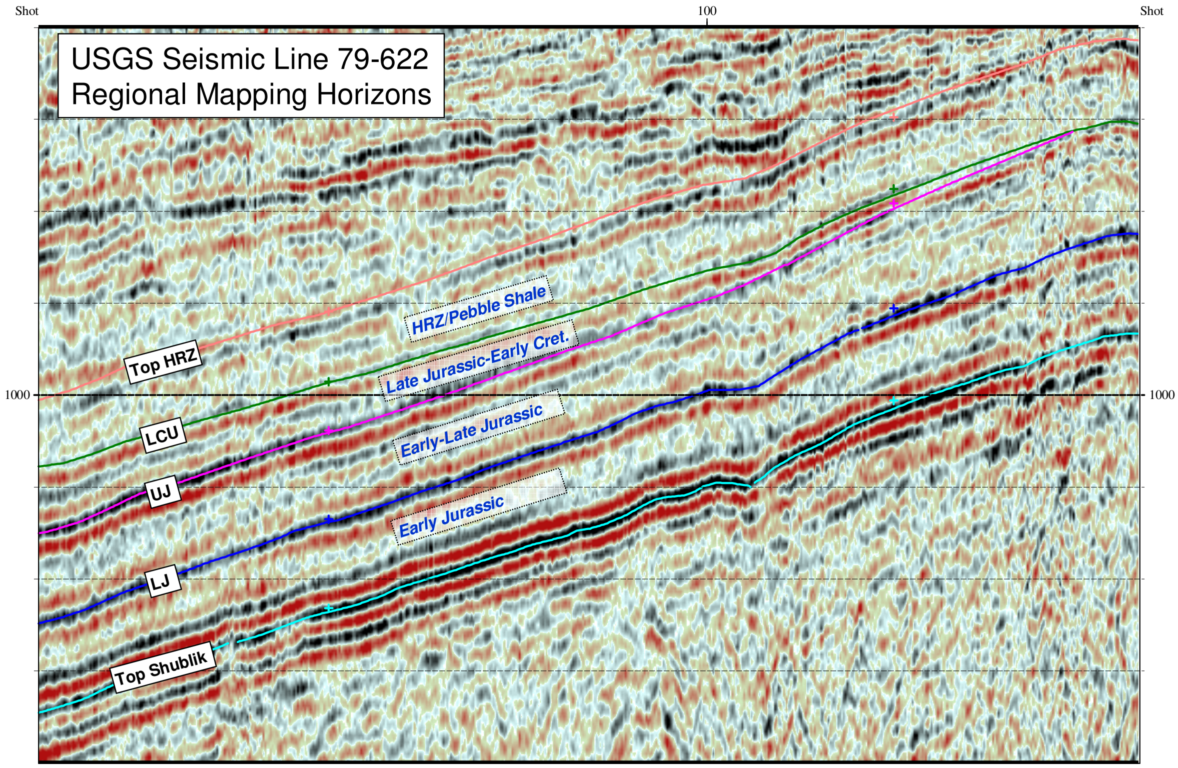

Figure 11: Regional mapping horizons and interval ages

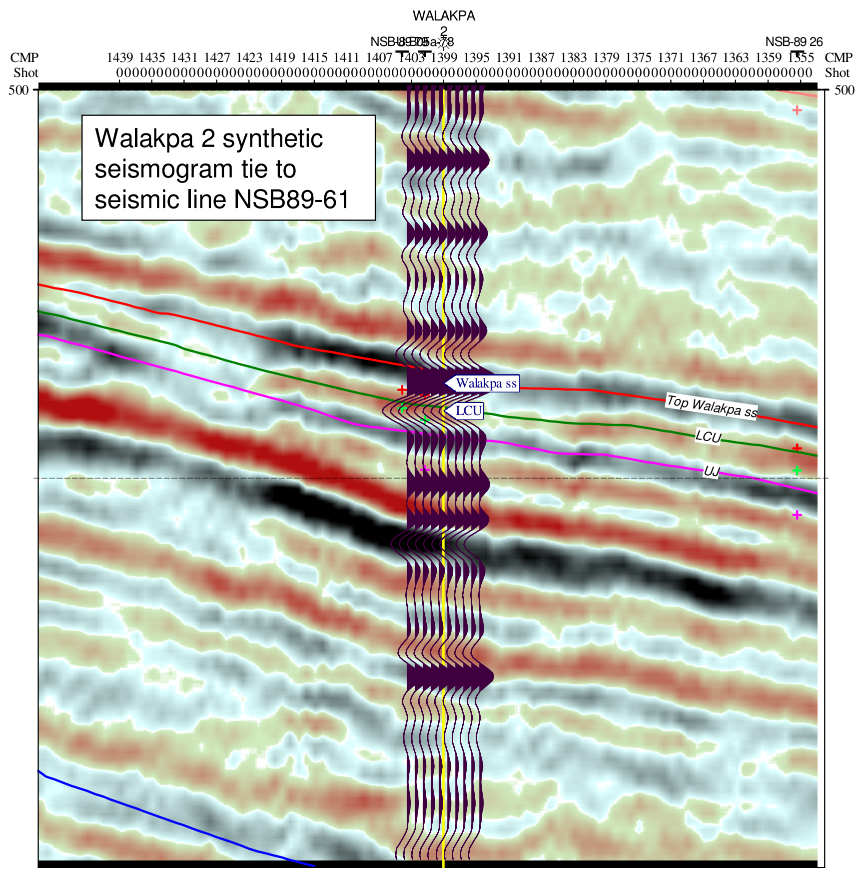

Figure 12: Top Walakpa sandstone horizon within the Walakpa Gas Field

Top U. Barrow sandstone – The top of the Barrow sandstone was picked sub-regionally across the East Barrow, South Barrow, and Sikulik field areas. It is most closely associated with a broad, low amplitude trough on USGS seismic lines. On the higher resolution NSB lines in the South Barrow and Sikulik areas a peak is resolved at the Top Barrow, but the event is still weak and difficult to pick. In areas of uncertainty the event was picked so as to best preserve the isochron thickness of intervals above and below. An example synthetic seismogram tie is shown in Figure 13.

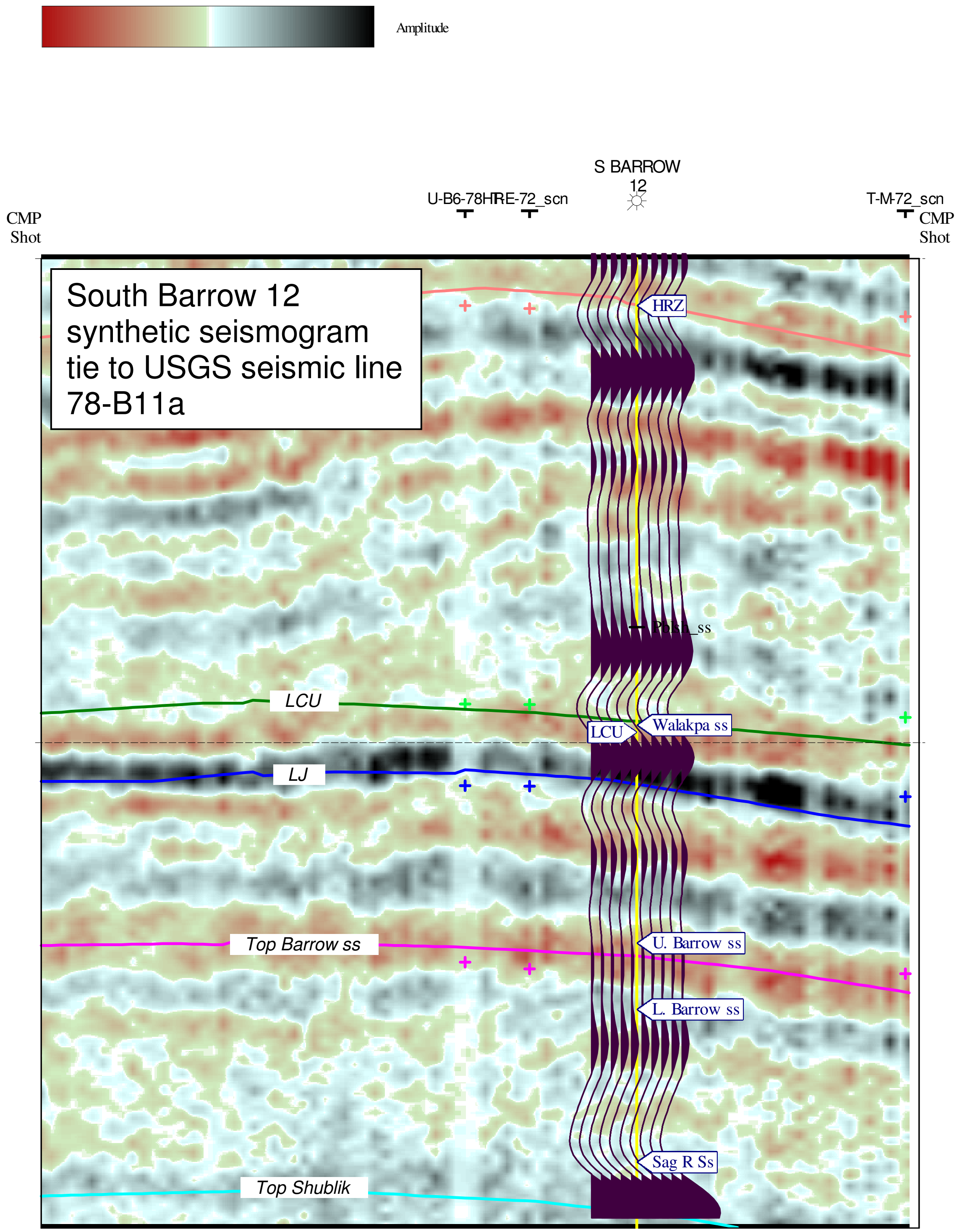

Figure 13: Top Barrow sandstone horizon within the East Barrow gas field

Faults were interpreted, and correlated fault surfaces were created where faults could be confidently mapped across multiple seismic lines.

DEPTH CONVERSION AND MAPPING

Final maps were generated in depth on regional, sub-regional, and field scales. Depth conversion was accomplished based on average velocity calculated from well control. Fault polygons were created for correlated faults and incorporated into the mapping grids.

Figure 14 shows a regional average velocity example for the LCU horizon. For final depth maps grids were adjusted to provide exact ties to interpreted well picks, within the constraints of selected grid spacings and algorithms.

Figure 15 shows the final depth map for the LCU horizon. A 2000 ft grid increment was selected for this and other maps that cover the entire region. This increment appeared to best express the structural features of the area without creating excessive “noise” in the contours. At smaller grid increments shorter wavelength erroneous features become more visible. These non-geological features can be caused by lake statics, residual misties, and erroneous gridding in areas of sparse control.

Regional structure is dominated by 1) the Barrow uplift, a post-Early Cretaceous structural high that culminates between the Walakpa and Barrow gas fields, and 2) the Avak Crater, an area of chaotic geology and reflectivity that has been interpreted as a post-Early Cretaceous impact feature (Kirschner, et al., 1992). Regional fault trends are in a generally east-west direction, which is consistent with the orientation of Beaufortian age faulting; however, most of the faults show significant displacement at the HRZ horizon and above, with little observable growth, so they may be largely post-Early Cretaceous in age. The Iko Bay fault is the most continuously interpreted fault in the region, but this may be misleading. The seismic lines which define this fault are widely spaced and would also allow for a less continuous fault interpretation.

The South Barrow, East Barrow, and Sikulik gas fields are located on the northwest, east, and south sides of the Avak crater, respectively, and are structural traps associated with that feature. The Walakpa gas field is located on the south flank of the Barrow High. The trapping mechanism for this field is not clearly understood.

Field scale depth structure maps for producing reservoirs were created for the four gas fields. Figure 16 shows Top Walakpa sandstone depth structure for the Walakpa field area, and Figure 17 shows Top Barrow sandstone depth structure for the East Barrow field. Both maps utilize a 500 ft grid spacing and are tied to well control.

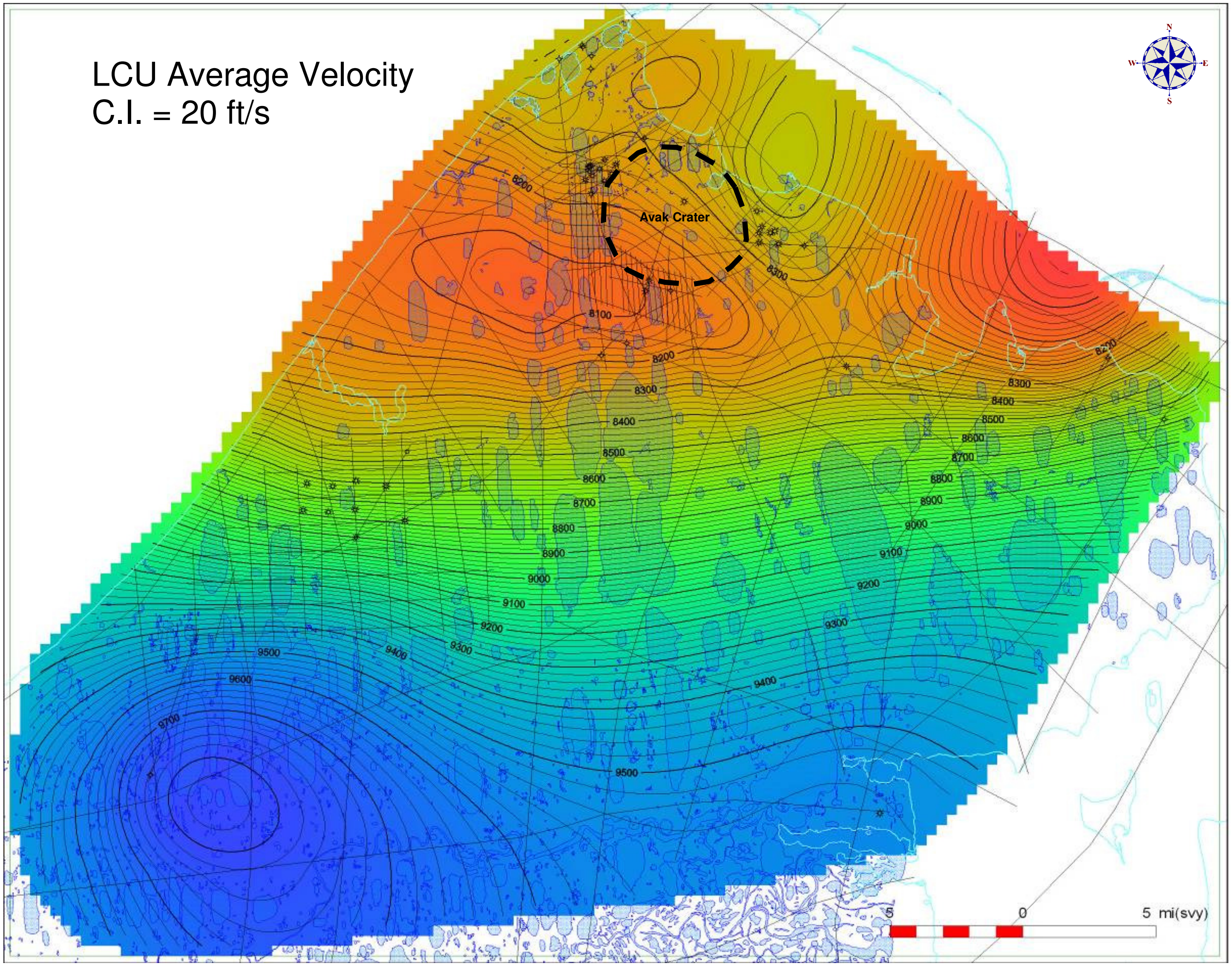

Figure 14: LCU smoothed average velocity from well control

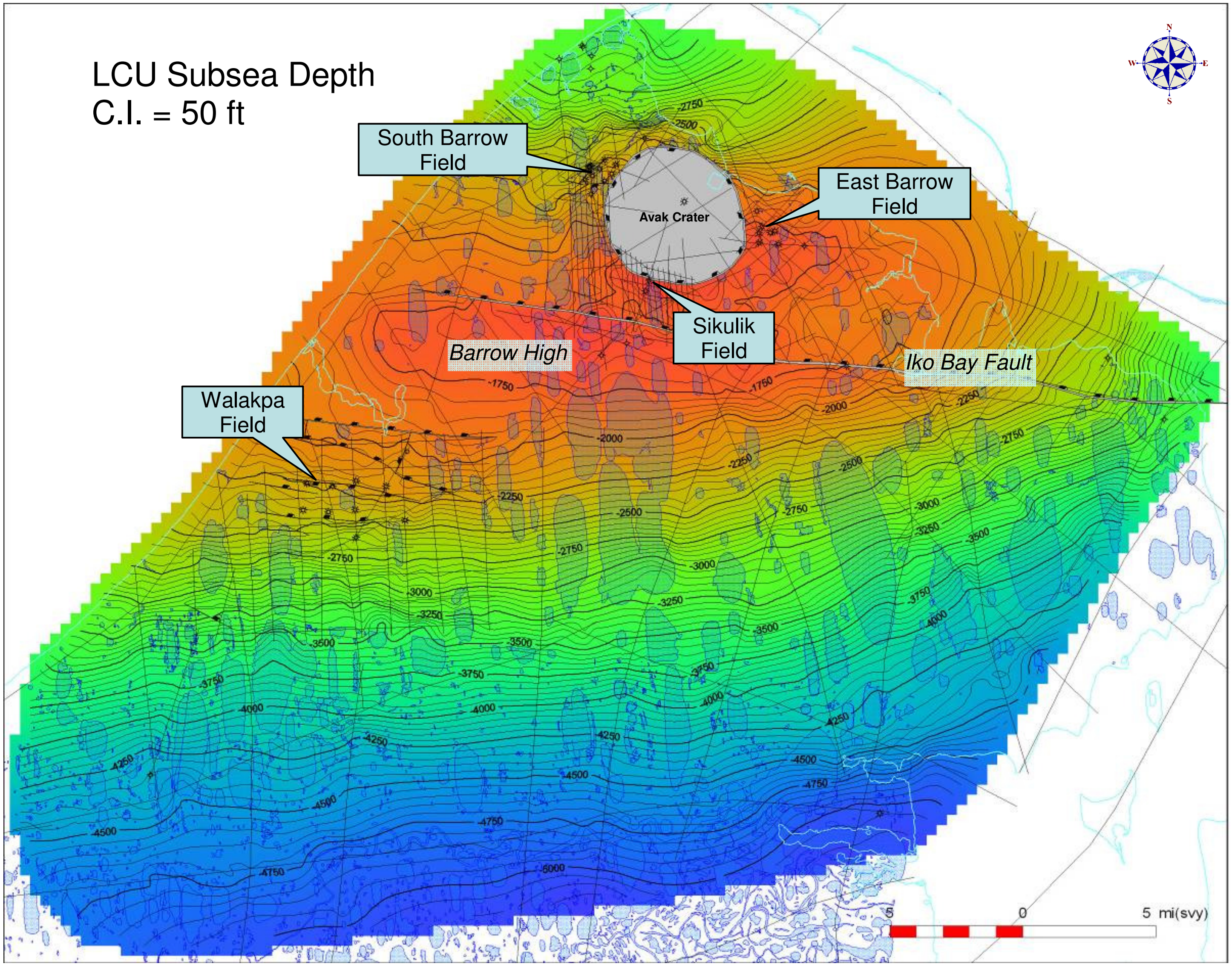

Figure 15: Regional depth structure map for the LCU horizon

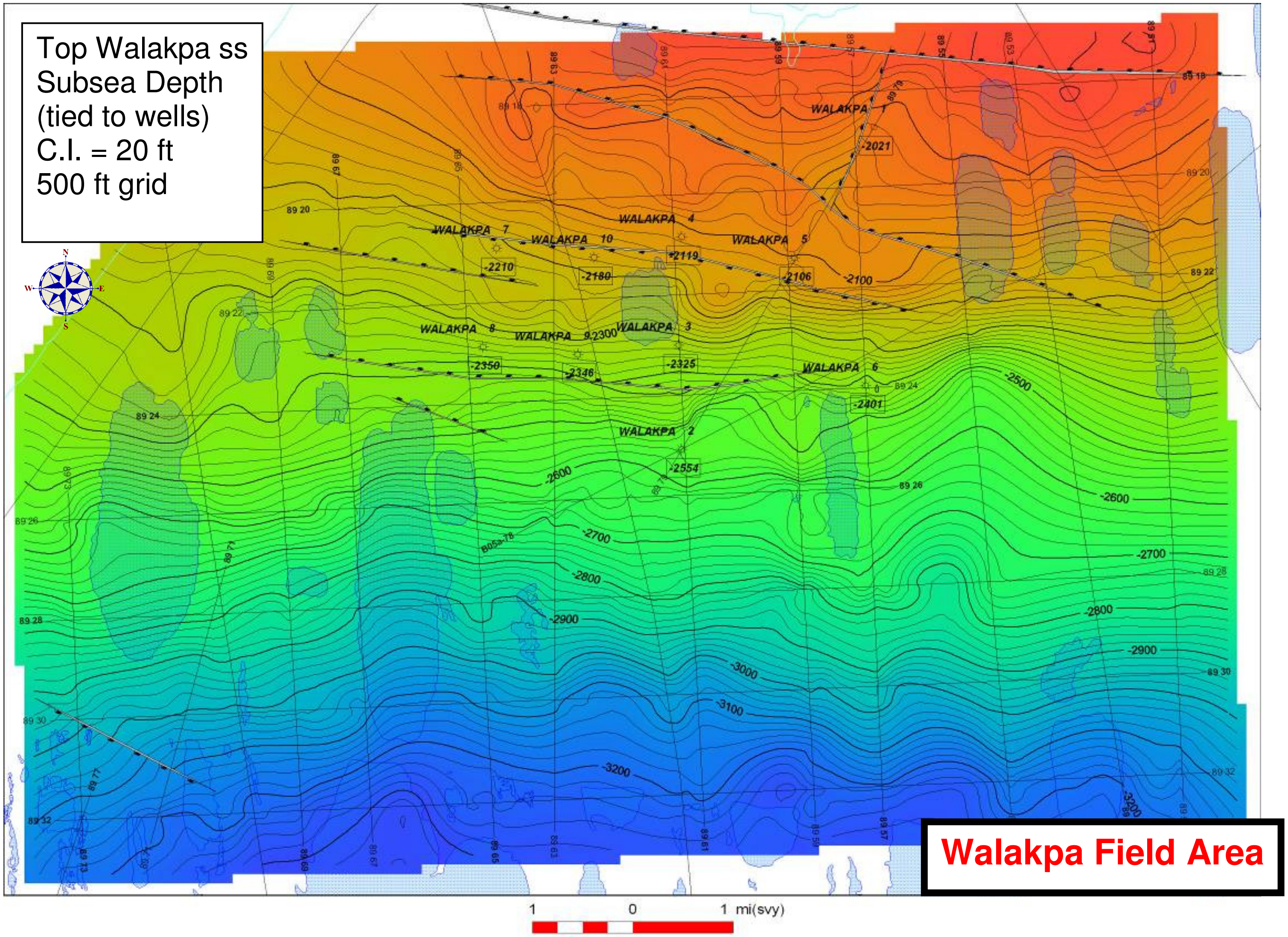

Figure 16: Top Walakpa sandstone subsea depth

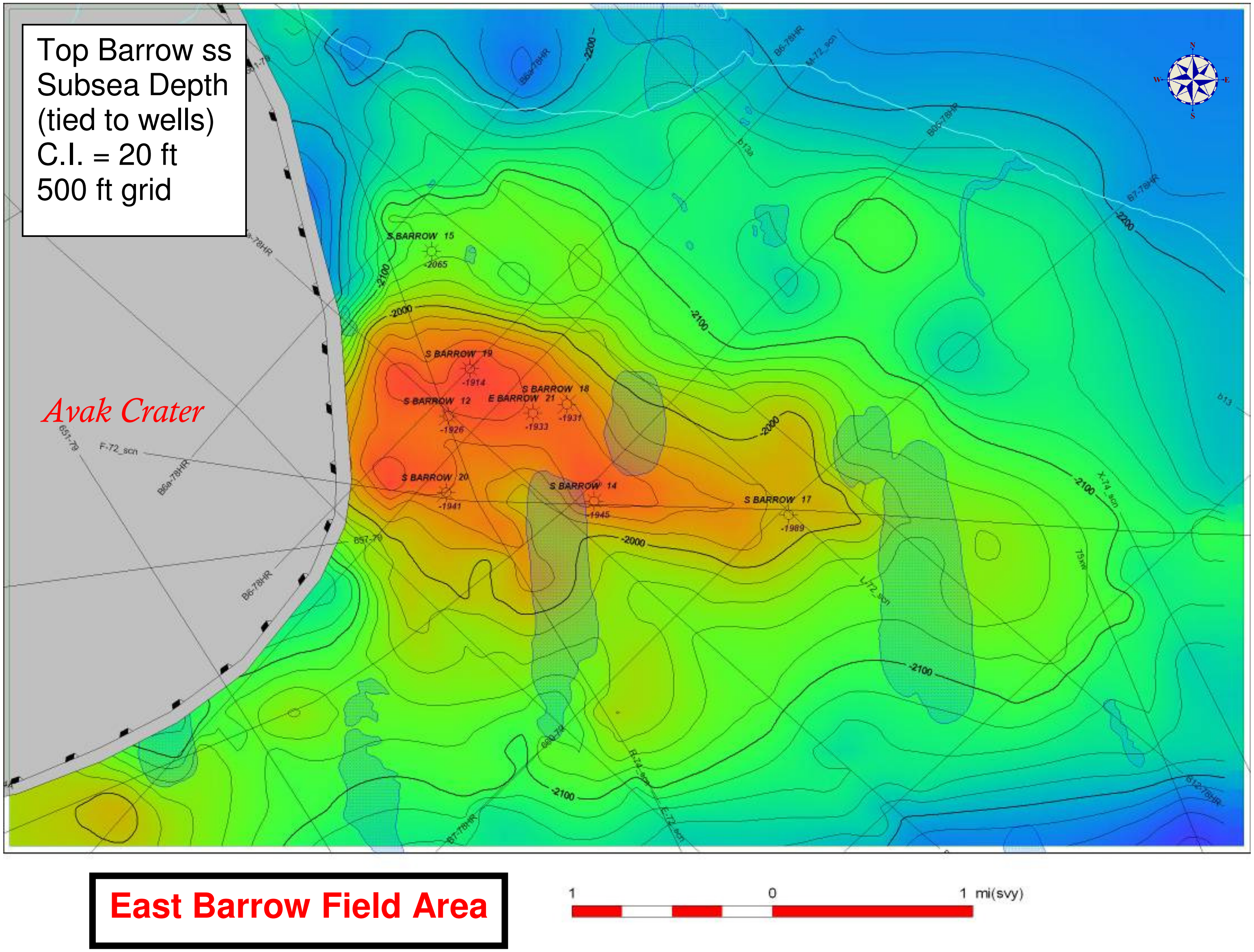

Figure 17: Top Barrow sandstone subsea depth

WALAKPA SANDSTONE DISTRIBUTION FROM SEISMIC

One of the objectives of the seismic evaluation was to gain insight into the distribution, thickness, and quality of the Walakpa sandstone away from current well control. At the outset of this study, it was not clear that the Walakpa Sandstone extended updip of the Walakpa #1 well to any great distance. If present, the reservoir would be within the gas hydrate stability zone. To date, detailed seismic modeling work has not been undertaken on the unit, primarily because of the relatively poor seismic data quality outside of the Walakpa Field area and because of LCU subcrop effects. Figure 18 shows maximum amplitude (gridded and smoothed) on the peak associated with the top of the Walakpa sandstone (see Fig. 12). The low amplitude region trending northwest-southeast through the Walakpa 8, 9, and 2 wells appears to be associated with truncation of the UJ horizon, rather than with thickness changes (Fig. 19) or other reservoir property variations within the Walakpa sandstone. Any modeling effort would have to account for subcrop acoustic impedance variations and associated side-lobe effects, as well as Walakpa sandstone impedance and thickness variations, and the results would likely be ambiguous. More detailed seismic to well correlation work together with zero-offset and AVO response modeling could be undertaken, if desired, but may be of limited value.

Direct mapping of Walakpa sandstone isochron thickness is not possible on a regional basis because the unit is below seismic resolution in all areas updip of the Walakpa Field and in all data sets except the 1989 NSB seismic lines. However, from the Walakpa Field area south to the Brontosaurus 1 well there appears to be a close correspondence between Walakpa sandstone thickness values from well control and HRZ to LCU isochron values. The HRZ to LCU interval consists mainly of the pebble shale unit, which is anomalously thick in the northwest portion of NPR-A compared to areas to the east.

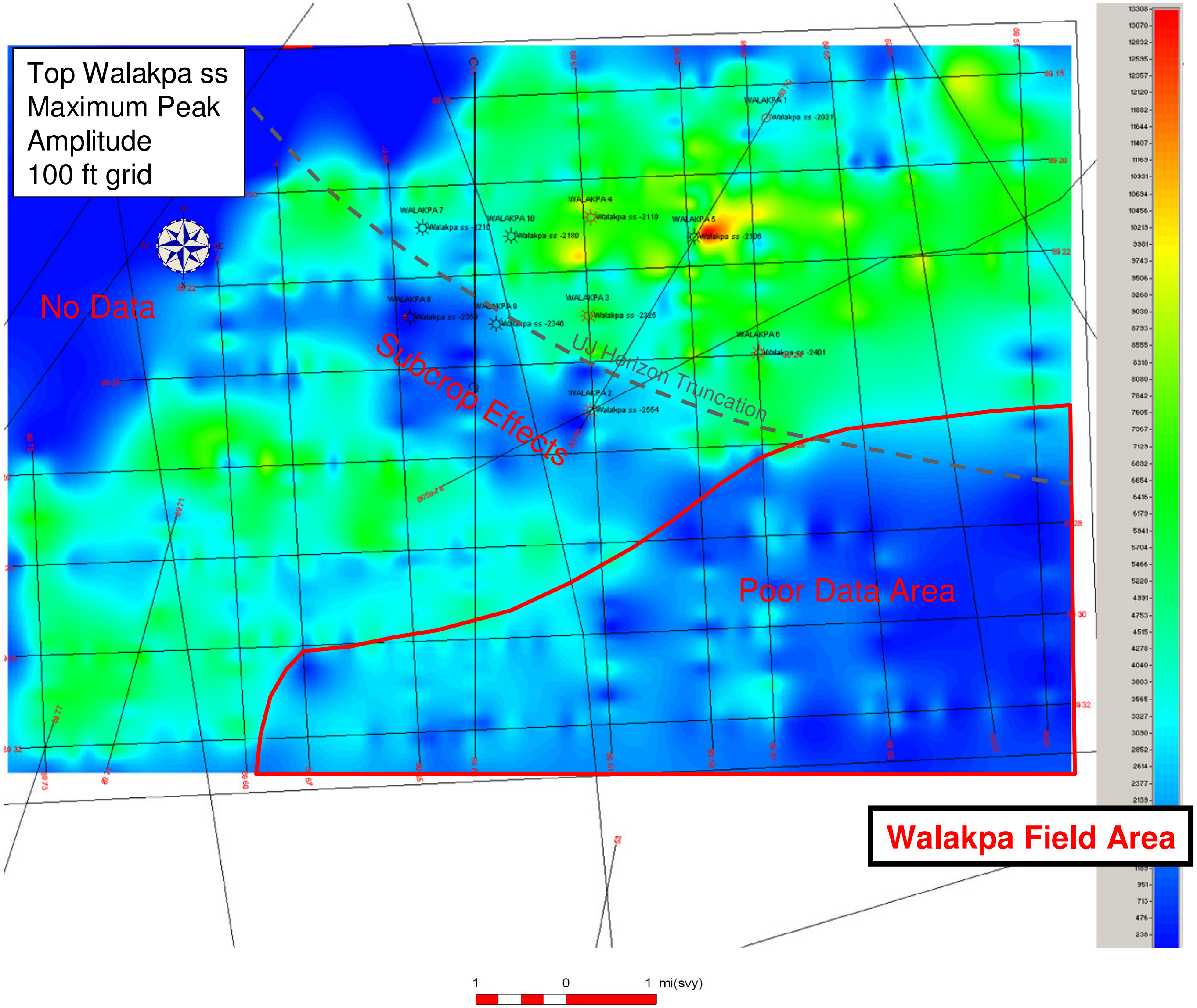

Figure 18: Walakpa sandstone maximum peak amplitude

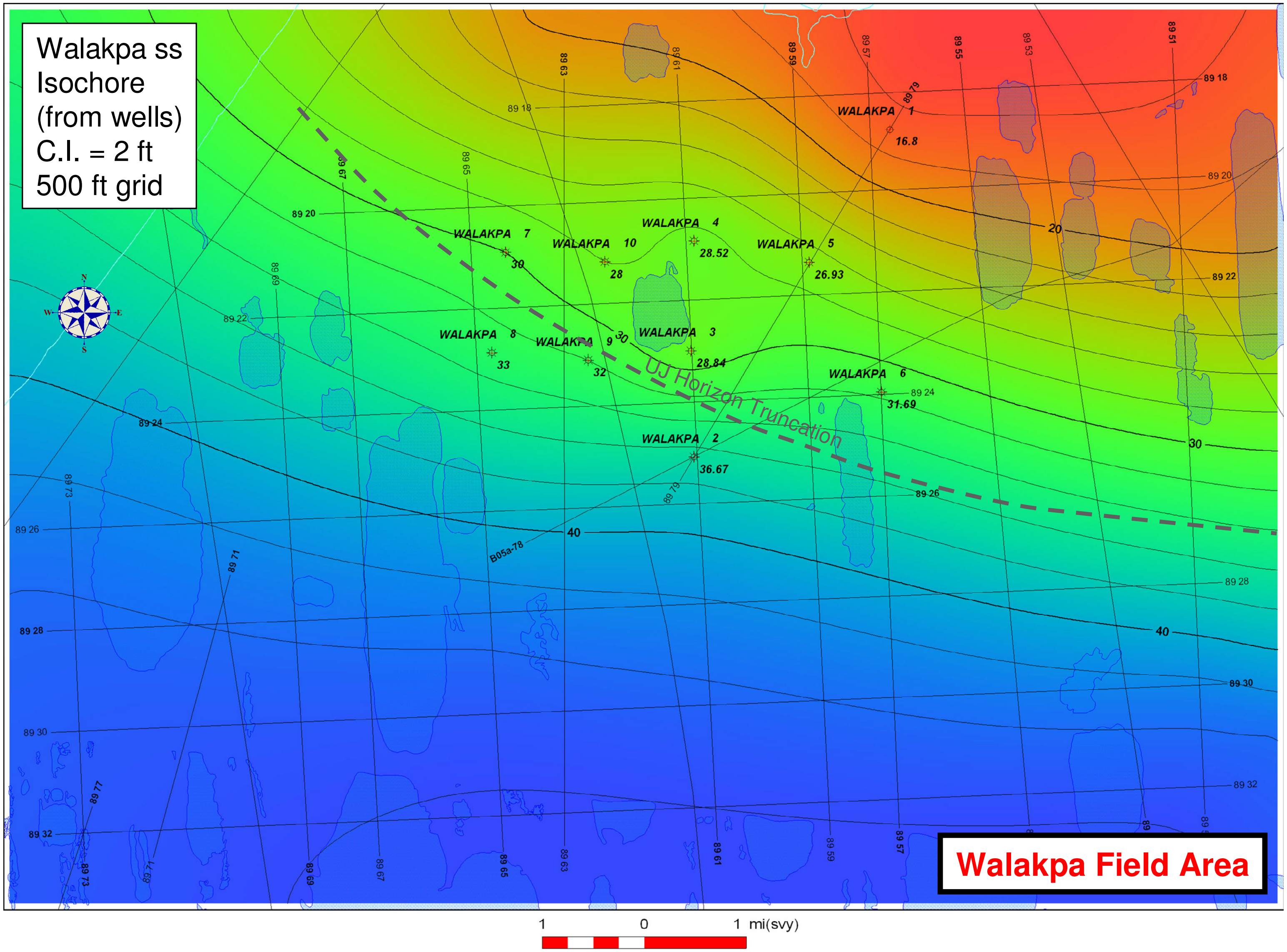

Figure 19: Walakpa sandstone isochore map, from well control only

Figure 20 is a composite map showing an interpreted Pebble shale plus Walakpa Sandstone thickness distribution (Base HRZ to LCU) based on the HRZ to LCU seismic isochron and compared to Walakpa sandstone thickness from well control only. The seismic isochron values were converted to thickness using a smoothed pseudo interval velocity map calculated from log isochores. There appears to be an area of depositional thickening within the interval to the east of the Walakpa Field and south of the Barrow fields that is similar to the area south of Walakpa. However, this eastern area has no well control and very sparse seismic control, so there is some uncertainty in the interpretation and mapping. The Walakpa sandstone may thicken dramatically in this area, but the prediction cannot be made with high confidence. The area is near the structural crest of the Barrow High (Fig. 15), so the Walakpa sandstone, if present, would lie within the gas hydrate stability zone, and would represent a very large hydrate resource.

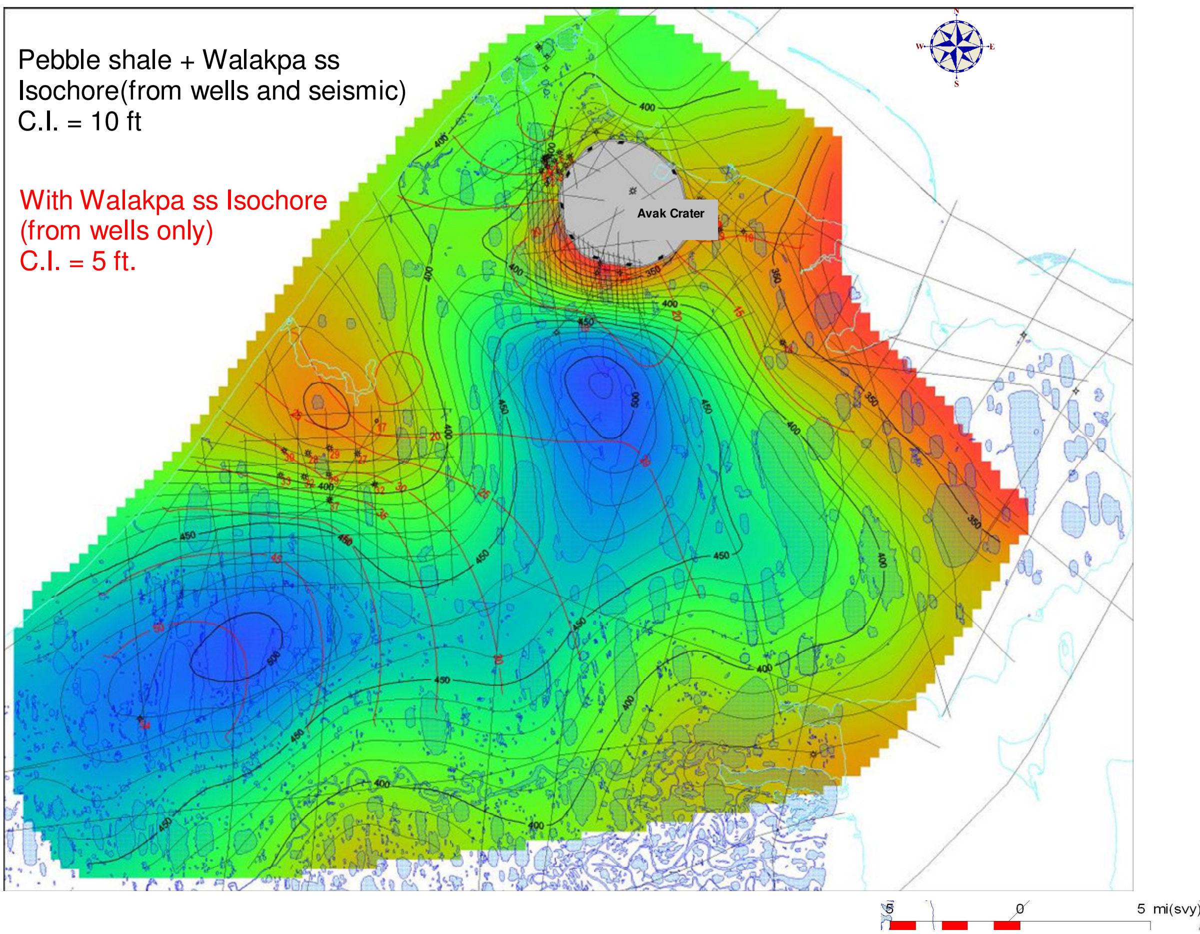

Figure 20: Comparison of Base HRZ to LCU thickness from wells and seismic to Walakpa sandstone thickness from wells only

WELL LOG AND CORE ANALYSIS

Well log and core information for all wells in the Barrow area were integrated and analyzed to quantify reservoir parameters, and to seek evidence for hydrate saturation. Core analysis data was available for two wells in the Walakpa Gas Field (Walakpa #1 and #2), and in one well within the Walakpa Sandstone interval 10 miles updip of the Walakpa #1 well (NSB-06). For the Barrow Sandstone interval in the South and East Barrow Gas Field and Sikulik areas, core analysis was located and integrated for seven wells (NSB-06, NSB-01, NSB-02, S.B.#15, S.B.#17, S.B.#18, and S.B.#19).

Table 1 contains the log-calculated reservoir parameters for the Upper Barrow Sandstone.

well	gross	net	net_pay	phi_pay	sw_pay	perm_net_sand
S B - 12	77.15	54	17.5	0.208	0.591	97
S B - 13	44.87	13	9	0.171	0.602	13
S B- 14	76.55	52	23.5	0.199	0.593	28
S B - 17	80.29	40	12.25	0.194	0.593	37
S B - 19	72.61	58	36.11	0.199	0.571	32
S B - 20	79.34	55	39.99	0.181	0.574	18
S B - 15	81	45	12.5	0.202	0.59	29
S B - 18	77.76	61	36.75	0.194	0.589	27
NSB-01	58	28	23.75	0.19	0.559	26
NSB-02	62.18	46	37.58	0.197	0.541	39
NSB-03	82	38	6	0.194	0.627	16
NSB-05	84.13	38	1	0.234	0.627	20
NSB-06	85.16	37	4.5	0.202	0.612	25

Table 1: Log-calculated reservoir parameters for Upper Barrow Sandstone

Table 2 contains log-calculated reservoir parameters for the Lower Barrow Sandstone.

well	gross	net	net_pay	phi_pay	sw_pay	perm_net_sand
S B - 12	21.63	16.50	16.5	0.227	0.343	236
S B - 14	28.1	24.95	23.5	0.246	0.368	315
S B - 17	26.79	24.25	12.25	0.264	0.476	364
S B - 19	18.12	17.89	16.89	0.22	0.499	97
S B - 20	20.7	18.20	17.51	0.217	0.387	212
S B - 15	21.16	11.00	0		0.98	33
S B - 18	20.87	20.75	19.25	0.223	0.401	184
NSB-01	29	17.00	15.5	0.187	0.536	29
NSB-02	22.67	14.42	8.92	0.201	0.558	41
NSB-03						
NSB-05	17.31	15.50	13.5	0.234	0.503	529
NSB-06	15.55	11.96	5	0.239	0.564	103

Table 2: Log-calculated reservoir parameters for Lower Barrow Sandstone

Table 3 contains log-calculated reservoir parameters for the Walakpa Sandstone.

well	gross	net	N/G	porosity	perm	sw
WALAKPA - 1	16.80	13.50	0.804	0.195	95	0.491
WALAKPA - 2	36.67	27.00	0.736	0.217	309	0.524
WALAKPA - 3	28.84	24.00	0.832	0.201	141	0.419
WALAKPA - 4	28.52	23.50	0.824	0.204	142	0.428
WALAKPA - 6	31.69	25.50	0.805	0.2	159	0.442
WALAKPA - 7	30.00	26.00	0.867	0.221	362	0.43
WALAKPA - 8	33.00	28.50	0.864	0.212	208	0.417
WALAKPA - 9	32.00	28.00	0.875	0.208	196	0.365
WALAKPA - 10	28.00	26.50	0.946	0.213	303	0.318

Table 3: Log-calculated reservoir parameters for Walakpa Sandstone

The Walakpa "sandstone" interval is present in the Sikulik area along the south rim of the Avak, and in the NSB-06 well (Figure 21). A well developed sand at 1600ft. MD in this well is 10 ft. thick, and very similar in character to the thicker Walakpa sands ten miles to the southwest in the Walakpa Field. However, even thought this clean sand has good resistivity and good porosity (20+%), there is no density-neutron cross-over, as would be expected in a gas sand, and the sonic log depicts high velocities in the sandy interval. This interval was tested, resulting in no flow to the surface. This interval was also cored, with no mention of hydrate in the core description; however, there were no provisions to preserve the core for hydrate detection. One could interpret the log and test results on this well to indicate that the Walakpa sands are hydrate-bearing in this location, in agreement with the results of hydrate stability modeling.

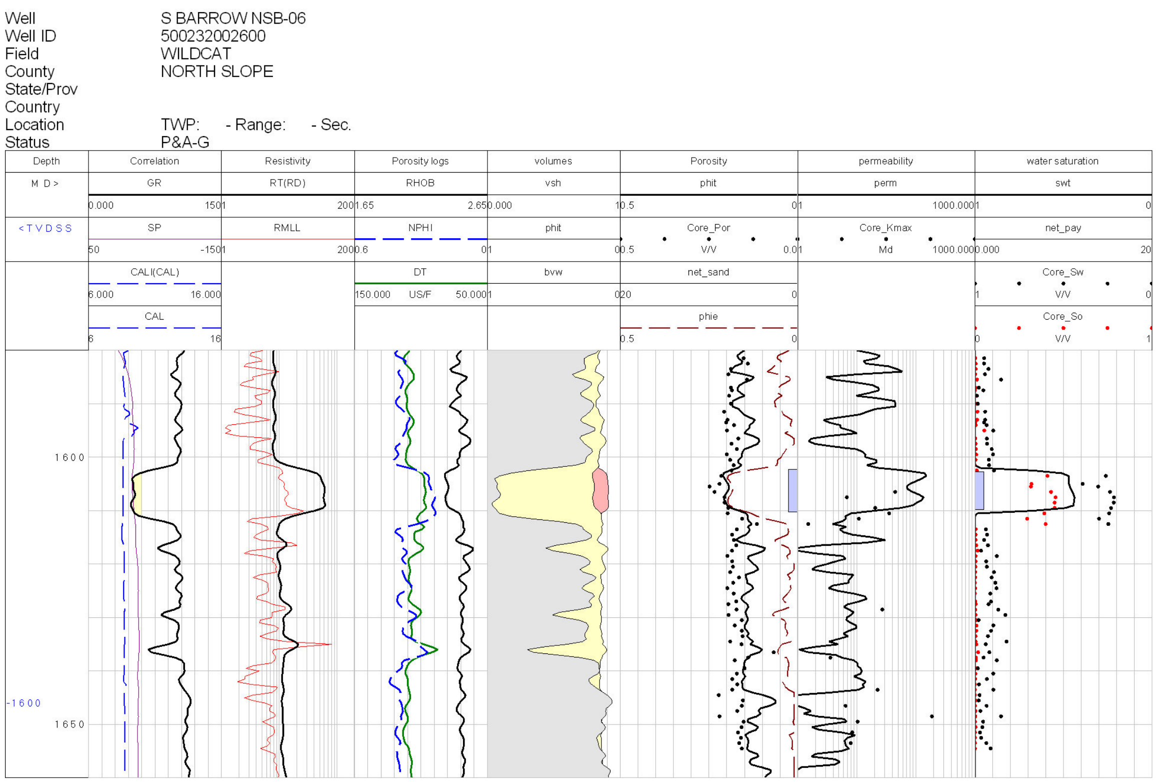

Figure 21: Well log display over Walakpa interval in NSB-06 well

Further north in the South Barrow Field the unit is hydrocarbon-bearing sand with good reservoir properties, and it was included in the completion interval of 7 wells; however, the thickness is only around 5-12 ft. and there is no breakout available on how much this sand has contributed to the production there, if at all. Figure 22 is a regional cross-section showing the Walakpa sandstone characteristics in the Walakpa, Sikulik, and South Barrow Fields. Also of note are the sandstones within the overlying Pebble shale in the NSB 1, 3, 4, and 6 wells. These sandstones are widely distributed within the area surrounding the Avak crater, but individual sands are difficult to correlate from well to well. A DST in the NSB-03 covered both the Pebble shale sandstones and the Walakpa interval, but there was no flow. This and other similar sandstones within the Sikulik and East Barrow field areas are very likely hydrate-bearing sands, although no hydrate sample has yet been collected.

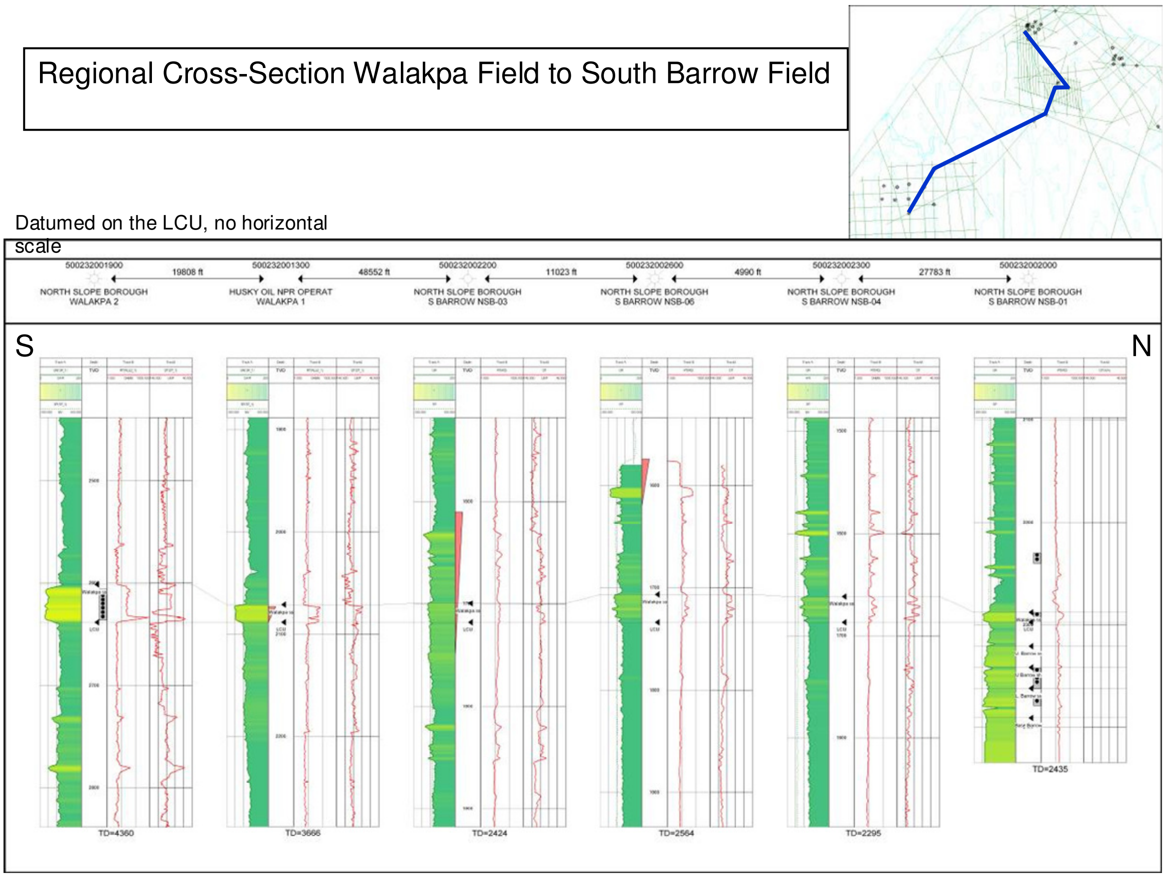

Figure 22: Regional cross-section datumed on the LCU and showing the Walakpa and Pebble shale sandstones

The Walakpa #1 well is the most updip well in the Walakpa Gas Field, and it was cored, logged and tested, with good reservoir quality in the Walakpa interval, and good initial flow test results. However, after initial tests, the well failed to flow, and was shut in. The logs for this well (Figure 23) show good gamma ray response, and high resistivity, but very little or no density-neutron cross-over, in contrast to other Walakpa well log responses. Sonic log response shows high velocities in the Walakpa interval, but this seems to be standard in this interval, and is probably not diagnostic of hydrate saturation.

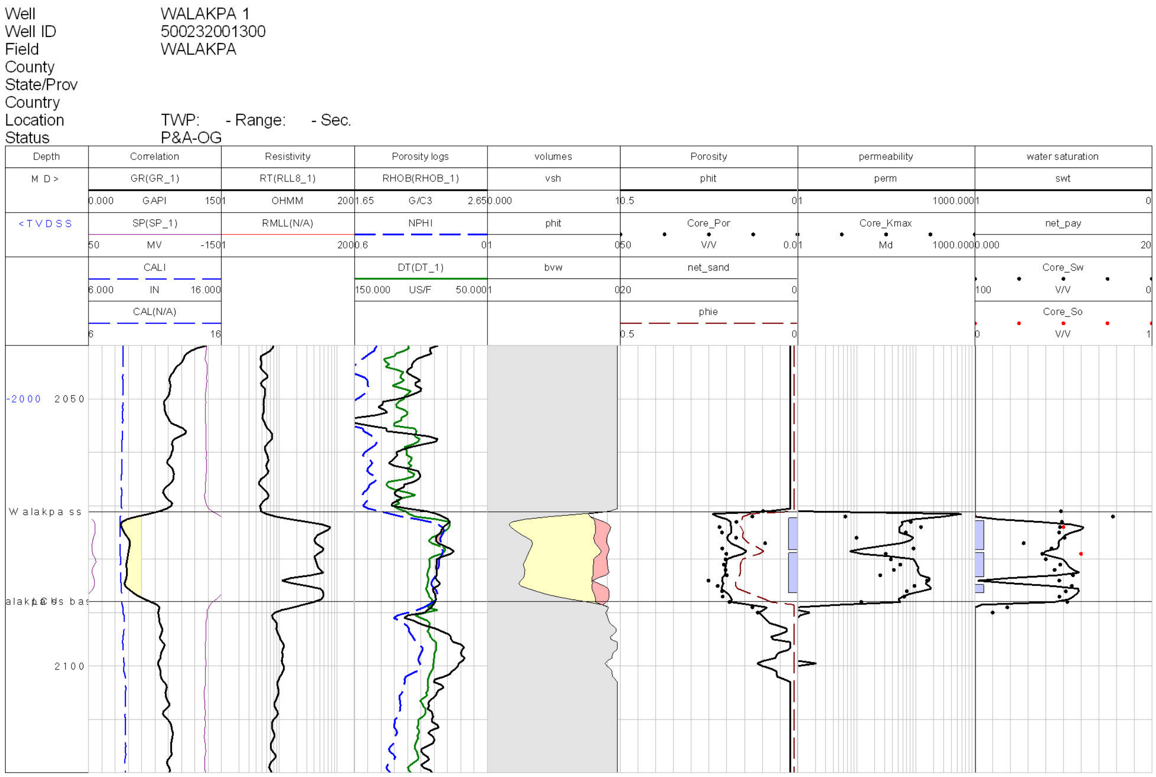

Figure 23: Walakpa #1 well log display

The Upper and Lower Barrow sands in the crestal wells in the East Barrow Gas Field are in the modeled hydrate stability window, but well log response is equivocal regarding hydrate saturation. In general, sonic log character in the Barrow sands reflects lower velocities in the sands versus the shale intervals. However, in the crestal wells, spiky sonic log character may be an indicator of residual hydrate saturation after drilling activity warms the interval and dissociates in situ hydrates. Figures 24 and 25 show the well logs for the S.B.-12 and S.B.-19 wells, respectively, showing the spiky nature of the sonic logs in the Lower Barrow Sandstone interval. However, this is unfortunately fairly weak and inconclusive evidence.

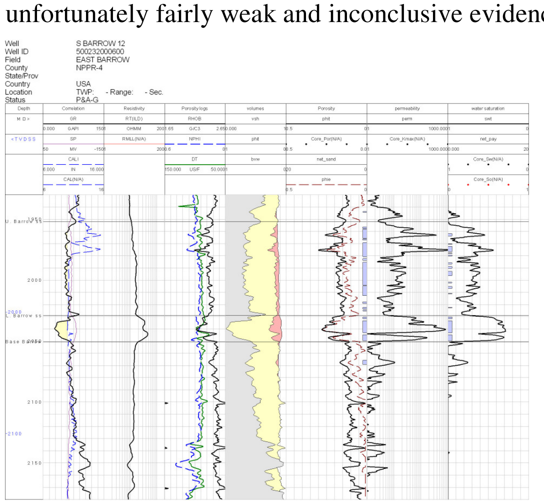

Figure 24: S.B.-12 Well log display

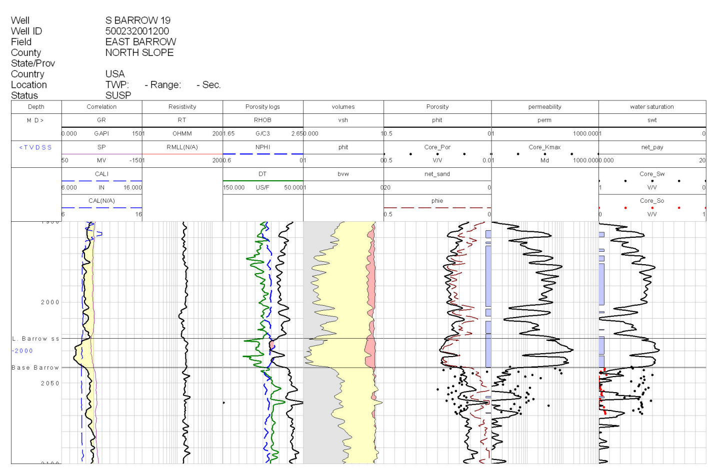

Figure 25: S.B.-19 Well log display

The well log displays for all 25 wells included in the petrophysical analysis are included in Appendix 1.

CONCLUSION

The Walakpa sandstone is expected to be present immediately north of the Walakpa Field, and the regional distribution of the unit suggests that it may be continuous and of good reservoir quality northeast to the South Barrow Field area, and even to the crest of the Barrow Arch. It is also possible, based on the seismic isochore, that the sandstone thickens significantly to the east of the Walakpa field, but this is not a high confidence interpretation. Additional sandstone units within the overlying Pebble shale interval should also be considered as possible gas hydrate targets.

The Barrow sandstone in the East Barrow Field appears to have been drilled near the structural crest of the field (Fig. 18), and both the Upper and Lower Barrow sandstone reservoirs fall within the modeled methane hydrate stability zone. The Upper Barrow sandstone, which is of poorer reservoir quality within the field area than the Lower Barrow and was not completed in most wells, should contain gas hydrates and over a larger area than the cleaner Lower Barrow sands and all of our modeling results indicate that this resource is contributing to the production and pressure stabilization of the East Barrow Gas Field.

The results of this seismic, well log and core evaluation have been incorporated in the integrated reservoir model for the East Barrow and Walakpa gas fields, and represent a significant improvement in our understanding of the characteristics of these two fields, and the regional geology.

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