9-2002

3-D Seismic Exploration Project, Ute Indian Tribe, Uintah & Ouray Reservation, Uintah County, Utah

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FOSSIL ENERGY

DOE/BC/15193-1
(OSTI ID: 800800)

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Annual Report
September 13, 2000-September 13, 2001

By:
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Date Published: September 2002

Work Performed Under Contract No. DE-FG26-00BC15193

Wind River Resources Corporation
Roosevelt, Utah

National Energy Technology Laboratory
National Petroleum Technology Office
U.S. DEPARTMENT OF ENERGY
Tulsa, Oklahoma

DOE/BC/15193-1
Distribution Category UC-122

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Historical Background

The Uinta Basin of northeastern Utah has been an important producer of oil and gas for more than fifty years. Included within the Uinta Basin is the approximately 1.2 million-acre Uintah and Ouray Reservation of the Ute Indian Tribe, with its headquarters in Ft. Duchesne, UT. Oil and gas have been produced from Tribal lands in significant quantities, also for more than fifty years.

The vast majority of oil and gas production from the Uinta Basin, including from Tribal lands, has been from the Tertiary Green River and Wasatch formations in the deeper portions of the basin, particularly in the Greater Altamont-Bluebell Area, Greater Natural Buttes Area and Red Wash Field. Exploration activity in these areas date back to the late 1940s and early 1950s, when several major oil companies engaged in wildcat drilling throughout the basin. Both this early activity and several episodes of later exploration effort resulted in the discovery of large reserves of oil and gas. As there was no gas pipeline to transport gas out of the Uinta Basin until late1962, most of the gas wells drilled prior to that time were drilled and abandoned.

Although considerable 2-D seismic was acquired in the Uinta Basin from the 1960s through the 1980s, the most recent stage of seismic exploration technology passed this basin by. Prior to the 3-D seismic survey discussed in this report there were only two small 3-D surveys shot in the basin: an approximately 10 square mile survey on Leland Bench, and a smaller survey narrowly designed to solve a particular technical problem at Natural Buttes. The reasons for this lack of seismic exploration effort include high costs associated with difficult topography, lack of confidence in data quality due to near-surface reflectors, and a general orientation toward step-wise expansion of the existing large fields. Generally weak gas markets also contributed to a lack of interest in exploring areas thought to be primarily gas-bearing.

The Ute Indian Tribe owns large tracts of largely unleased mineral acreage in the south and southeastern areas of its reservation where a thick multi-formation sedimentary section is structurally high to the more developed portions of the basin. This structural advantage can be attributed to the basin margin location of this acreage and its elevation by the buried Uncompahgre Uplift. The result is that nine prospective oil and/or gas producing formations are accessible by drilling to a depth of 12,000' or less, whereas only two or three of these formations can be reached at this depth in the areas of existing development on the reservation. This area of the reservation is known as the Hill Creek Extension.

Wind River Resources Corporation (Wind River) made its proposal to the Department of Energy under NPTO Program Solicitation DE-PS26-99BC15184 for partial funding of a 3-D seismic survey in October of 1999. The proposal was for a 15 square mile survey to be conducted in a highly prospective area of the Hill Creek Extension.

In May of 2000, Wind River received notice from the DOE that its proposal had been tentatively accepted. By this time Wind River had identified a survey area and begun negotiating with the Ute Indian Tribe and the Uintah & Ouray Agency of the Bureau of Indian Affairs for an Exploration and Development Agreement covering the identified acreage in Township 15 South – Range 20 East, Uintah County, Utah.

As soon as it was clear that the 3-D survey was likely to get funding during calendar year 2000, Wind River undertook the biological and archaeological field studies that would be required to permit the survey. At the same time, the owner/operator of the Flat Rock oil and gas field, located in Sections 28, 29, 30 and 32 – Township 14 South – Range 20 east, was approached to determine if his company would have an interest in expanding the survey to cover their acreage and producing wells. This was an important step, because the DOE funds could only be used on "non-allotted Native American...lands" and could not be spent on split estate lands, such as Flat Rock field, where the surface was tribal trust land but the mineral estate belonged to the federal or state governments. The wells at Flat Rock would provide vital well control for the survey.

The Flat Rock operator, Orion Energy Resources, responded very positively to an invitation to participate in the survey and the survey area was expanded to 25 square miles. The survey area now included an analog field with approximately twenty wells ranging in depth from 3,500' to 12,897'. It included a newly drilled, but not yet completed, 11,600'-deep wellbore suitable as the host for a vertical seismic profile to be used to tie the seismic survey data to the known formation tops as determined from the well logs.

There is a perimeter approximately half a mile wide around a survey of this type where full fold cannot be achieved. Since the width of this reduced fold area is fixed, expanding the area of the survey significantly increased the ratio of full fold coverage area to reduced fold coverage and allowed a more efficient survey.

3-D Survey Design

The objectives of the North Hill Creek 3-D seismic survey were to:

- Cover as large an area as possible with the available budget
- Obtain high quality data throughout the depth range of the prospective geologic formations of 2,000' to 12,000' to image both gross structures and more subtle structural and stratigraphic elements
- Overcome the challenges posed by a hard, reflective sandstone that cropped out or was buried just a few feet below the surface under most of the survey area

- Run a safe survey

The survey area was focused on an irregular shaped mesa at an average elevation of slightly more than 7,400' above sea level. The central portion of Flat Rock Mesa, named for the widespread outcropping of patio-like sandstone, is a nearly flat area covered by sagebrush. The mesa is bounded on east and west by the >1000-foot deep canyons of Willow Creek and Hill Creek, respectively. These canyons, and the incised drainages associated with them, create an area of extremely rugged topography all around the mesa. Most of the drainage areas, and some of the flats, are covered by pinion and Utah juniper, and in a few places by aspen and spruce trees. (See topo map)

The objective of keeping acquisition cost per square mile reasonable precluded the use of the helicopter-supported shot hole drilling that would be necessary if the survey area included the more rugged topography. The most efficient survey shape was determined to be a "T" taking in all of the flat, sage-covered acreage and as much of the rougher acreage as was necessary to maintain the integrity of the shape. That flat treeless area, about 80% of the total, would be surveyed using vibroseis buggies as the energy source, while articulated buggy shot hole rigs would be used to fill in as much of the rough terrain as practical with shot holes and dynamite as the energy source. It was decided that areas too rough to host source points would be covered with receiver lines in an effort to record as much of the data as possible.

With an unusually thick objective consisting of nine different geologic formations from 2,000 feet to 12,000' in depth, considerable effort went into the layout and design of the energy source and receiver patterns. The receivers were set out in east-west lines across the field area spaced 660 feet apart. Groups of six geophones each were spaced 220 feet apart along these lines. The source lines were oriented diagonally, northeast to southwest, with 1,320-foot source pattern spacing and 220-foot source intervals. This design was a cooperative effort among Western Geophysical (now Western Geco), Black Coral LLC and Wind River.

The actual survey consisted of 2,313 source points and 5,672 receiver points. 459 of the receiver points (19%) were shot holes drilled to 45 feet to 60 feet and loaded with 10 or 15 pound of dynamite. The remaining 81% of the source points were vibroseis stations occupied by four 59,000-pound articulated buggy vibrators. 1,046 of the receiver points were located in areas too rough to accommodate source points.

Field Acquisition of 3-D Seismic Data

This survey was performed under the terms of a Categorical Exclusion from the requirement of the National Environmental Policy Act, issued by the Uintah & Ouray Agency of the Bureau of Indian Affairs on September 9, 2000. The initial phase of fieldwork consisted of raptor surveys and endangered plant surveys conducted in June of 2000.

As soon as Wind River received notice that funding was in place for the survey, a team of archeologists and a team of biologists initiated block clearance surveys to identify any points or areas that would have to be avoided during the survey. The archeology report listed several sites for avoidance and the biological survey found no endangered plants or animals in the survey area. This work performed by AIA Archeologists of Laramie, WY, and Buys & Associates of Denver, CO. It was supervised for the Ute Indian Tribe by Alvin Ignacio of the Ute Tribe Energy and Minerals Department.

On September 26, 2000, Western Geophysical land surveyors entered the field with Trimble 4000 SSE GPS equipment, found their control points, established a radio repeater station, and commenced surveying the individual source and receiver points. Three to six teams of surveyors were employed in this work.

In early October two articulated buggy shot hole drilling rigs arrived in the field and began drilling and loading shot holes identified by the surveyors as unsuitable for the vibroseis buggies. On October 25th, 2000, the Western Geophysical Survey Crew 780 arrived in the field and began laying out cables in the extreme northwest portion of the survey area.

On October 28, 2000, Baker Atlas arrived in the field from Houston and Casper with equipment to run a zero offset vertical seismic profile in the recently drilled, but yet to be completed Del-Rio/Orion 32-11A. This 11,600-foot deep well was drilled inside the survey area and a complete suite of open hole logs had been obtained from it. Prior to the commencement of the vibroseis work on the survey, two of the AHV-3 vibrator buggies were located 234 feet from the wellhead and operated by the logging engineer to provide an energy source for the VSP. The VSP was run over an 18-hour period with the own hole receiver recording data at 50-foot intervals from 11,600 feet to 500 feet from the surface.

Upon completion of the VSP, the vibrators were deployed in the field to allow a day of sweep testing to determine the optimal acquisition parameters for the survey. It became immediately obvious that the hard sandstone layer at or near the surface that gave Flat Rock Mesa its name was going to be an obstacle to good data acquisition. Both the VSP and the sweep testing were supervised by Bret Gunneson and Jim Labo, consultants to Wind River.

Actual field data acquisition began on October 30, 2000, in the northwest portion of the survey area and was concluded on December 7, 2000, in the south central portion of the survey area. Although it was cold and snowy during most of the time that Crew 780 was in the field, only one day was lost to weather. The "ringy" character of the shallow Horse Bench sandstone member of the Green River Formation made it next to impossible to see the data in the field, so the entire survey was shot trusting that Western Geco would be able to process the data into a useable volume. The project manager for the field acquisition was Louise Sandberg and the crew chiefs for Western Geco Crew 780 were Randy Shannon and Mike Waugh. Jim Labo represented Wind River Resources in the field on a daily basis.

3-D Seismic Data Processing

Processing of the 3-D data volume commenced at Western Geco in Denver as soon as the field data acquisition phase was complete. Western's processing team consisted of Irina Nicholson, analyst, John Markert, group leader, and John Young, supervisor.

The original estimate for completion of the processing phase was six weeks, or approximately January 21, 2001. Black Coral's Dave Suek, Bret Gunneson and Paul Harrison, Marc Eckels of Wind River, and Mike Pentilla met regularly with the processing team at Western Geco to provide input and direction and assess progress. It was not, therefore, particularly surprising when the Western processors asked for additional time, largely due to the difficulty of processing out the noise created by the shallow reflector.

On February 14, 2001, the Western processing team made a presentation of the final processed data to Marc Eckels, Paul Harrison, Dave Suek, Bret Gunneson, David Allin and Mike Pentilla. The results were not only markedly improved from the previous progress meeting, but were actually very good.

Upon receipt of the final processed data volume, it was decided that subsequent specialized coherency and edge processing might be helpful in the interpretation phase. This work was performed by Applied Research Concepts in Denver.

3-D Seismic Data Interpretation

The processed seismic data were loaded onto workstations at Black Coral in Denver, at Paul and Denise Harrison's (Fall-Line Exploration) office in Silverthorne, CO, and at the office of Mike Pentilla in Denver. After an initial look at gross features and correlations to determine formation tops it was decided that the Harrisons would initially concentrate on the shallow Wasatch Formation while Mike Pentilla went to work on the deeper Dakota / Cedar Mountain/ Morrison intervals.

On April 30, 2001, a technical meeting was held at the Black Coral office in Denver. Present for this meeting were: Dave Suek, David Brewster and Jake Henderson of Black Coral; David Allin and Mike Pentilla, consultants to Del-Rio/Orion Resources; Randy Nickerson and Brian Coffin of Dominion Exploration and Production, who were interested in seeing the data as an aid to their seismic survey design effort for the Naval Oil Shale Reserve No. 2; Walt Johnson, a consultant to a Wind River partner; and Marc Eckels of Wind River Resources. A discussion of the initial interpretation presented at this meeting follows.

Phase One – Structural Analysis and "Deep" Mapping

The following maps were constructed for the "deep section" below the Cretaceous Mancos Formation:

> Triassic Chinle: Time Structure (Figure 3)
> Jurassic Navajo "Trough" Seismic Marker: Time Structure (Figure 4)
> Jurassic Navajo "Trough" Seismic Marker: Amplitude (Figure 5)
> (structure contours overlying amplitudes)
> Cretaceous Base Cedar Mountain Pay: Time Structure (Figure 6)
> Cretaceous Dakota Silt: Time Structure (Figure 7)
> Cretaceous Dakota Silt to Triassic Chinle: Isochron (Figure 7A)
> Cretaceous Dakota Silt to Base Cedar Mountain Pay: Isochron (Figure 7B)
> Cretaceous Castlegate Seismic Marker: Time Structure (Figure 8)

The seismic events picked in the construction of these maps are all generally good continuous reflectors. The main structural element on all of these maps is an anticlinal axis trending W-NW to E-SE, commonly referred to in the literature as the Hill Creek Anticline. The anticline is bounded on the south by a "deep" seated high angle reverse fault that seems to have been re-activated in Dakota and Mancos time and is probably the locus of transform (transtensional) faulting that creates structures in the younger section. Figure 2, "Regional Arbitrary Line – Major Fault Systems" and 2A "Cross Line 5230-Second View of Major Fault Systems, show the evidence for the tectonic history described above.

The arbitrary seismic line in Figure 2 passes through the Flat Rock Field. It shows some detail of the faulting in the Wasatch Formation and the reverse fault that cuts the Dakota and deeper formations.

Figure 2A, shows the deep high angle reverse fault in more detail. It also shows a near vertical fault (*transpressional* fault?) cutting up from the Dakota and through the Mancos section. Finally, it shows the *transtensional* faulting in the Wasatch section. Note that faulting in the Mancos may be attached to the deeper reverse fault but that Wasatch faulting is detached from the Mancos level faulting.

The transtensional faulting in the Wasatch is generally oblique to the deeper fault trend and the trace of these faults trend in a more westerly direction. Prior to shooting the 3D seismic survey, the Flat Rock Field was thought to be located on the Hill Creek Anticline. The seismic data shows the field to be located on the north flank of the anticline. However, there may be a structural element to the trapping of gas in the Wasatch provided by down to the south transtensional faulting.

The most prominent anomaly on the Chinle, Navajo Seismic Marker, Base Cedar Mountain "Pay", and Dakota Silt maps is a four-way closure in the northeast quarter of Section 9, 15S-20E. This closure is on the Hill Creek Anticline and is bounded on both the south-east and the north-west by saddles. Note how the isochron map between the Dakota Silt and the Chinle (Figure 7A) exhibits no thinning over this high. In fact this isochron map shows a thick along the axis of the anticline inferring that most of the structural growth occurred during Dakota deposition or at a later time. Essentially, all of the deep wells drilled to date are on the north flank of the anticline at least 20 ms (130'-150') down dip and outside of the mapped closures.

There are two other highs on the Hill Creek Anticline, one located at the south-east the edge of the survey in the east half of Section 13, 15S-20E and the other at the west edge of the survey in Section 31, 14S-19-E. There is probably closure on these highs that could be confirmed by acquisition of additional seismic data.

Detailed volume attributes in the deeper section were analyzed by others and are not part of this evaluation. However, an example of amplitude extraction can be seen on Figure 5, "Jurassic Navajo 'Trough' Seismic Marker-Amplitude". The amplitudes on this map show an interesting pattern probably related to aeolian dune trends. The two wells that have penetrated the Navajo were wet, but are located down dip and outside structural closure. There is an amplitude difference between the two wells. It would be constructive to compare the logs to assess differences in sand development that may be contributing to the difference in amplitude response and may be a consideration when selecting a future deep location.

The Isochron Map between the Dakota Silt and the Base Cedar Mountain Pay (Figure 7B) shows some interesting trends. These trends were noted by Mike Pentilla, who did a more detailed evaluation of the Dakota interval.

The Time Structure on the Castlegate Seismic Marker (Figure 8) shows very little relief along the axis of the Hill Creek Anticline. The highest point on this map is at the western edge off the survey in Section 31, 14S-19E. Some preliminary analysis of the seismic stratigraphy in the Castlegate /Sego Sands was done but a detailed interpretation of that interval was not completed as it was decided to focus on the Wasatch potential in this phase of exploration.

Phase Two – Shallow Mapping

A detailed interpretation was completed in the Tertiary Wasatch Formation. Mapping was restricted to those events below the BHR (base high resistivity marker) and above the top of the Mesaverde. A geologic framework was established by importing formation tops provided by David Allin of Del Rio Resources.

Wasatch Formation

The Wasatch Formation consists of lake margin fluvial and alluvial plain sediments. Lake Uintah was a significant body of water with a history of rising and falling water levels influenced by the periodic and sometimes major tectonic movement of the San Rafael, Uncompahgre and Uinta Uplifts and intermontane basin subsidence. The North Hill Creek 3D is located on the southwestern shore of the lake. Braided streams and fresh water deltas brought sediment from southern highlands towards the north and northeast. Within several of the mapped intervals, meandering high amplitude events representing marginal lacustrine channels or non-lacustrine alluvial-plain channels confirm this orientation.

The Flat Rock Field is productive from the Wasatch Formation, as well as deeper formations, and is located on the north flank of the Hill Creek Anticline. As noted in an earlier section of this report, transtensional faults displace Mesaverde and Wasatch Formations (See Figure 2, "Regional Arbitrary Line – Major Fault Systems"). This faulting may provide a structural element to trapping hydrocarbons in the Wasatch.

Method

A sequence stratigraphic model conforming with the nonmarine environment described above was used to identify major sedimentary features within the section. For mapping purposes, zones were named AA through H, older to younger respectively. As mapping progressed, additional zones were encountered and were given descriptive names such as 'A channel' and 'D unconformity'. This interpretation was then integrated with detailed well information including production data, DST's, mud log shows, and lithology.

A good correlation was observed between a relatively high amplitude trough and the uppermost pay sand in the Del Rio 32-1A well. Because of this correlation and an assumption that amplitude anomalies in troughs could be related to pay, each trough within the Wasatch was mapped. Each trough was labeled as a 'zone' which is defined as the interval between the zero-crossings above and below the trough. Each 'zone' represents a sediment package of approximately 65 feet.

Several unconformities were mapped that conform with the geologic model, i.e., erosional remnants, etc. They were generally but not always picked at a positive to negative zero-crossing.

During the efforts to integrate the seismic interpretation with the well data, it was determined, that for the most part where there was a trough anomaly, there was a potential pay package. However, pay zones were also seen where there is less coherent and continuous seismic character. It is assumed that these 'pay zones' are too thin to be expressed within the seismic resolution.

During the integration of well data with the seismic data, pay zones and other intervals were categorized by David Allin and annotated on each of the Wasatch Zone maps and vertical seismic illustrations as follows:

Perforated/Producing
Perforated/Tite
Probable Pay, defined by log analysis (resistivity >/= producing zones)
Possible Pay, defined by log analysis (resistivity borderline)
Tite, intervals defined by log analysis
Gas shows (from mud log assumed to be wet by log analysis)

It is concluded that thicker pay sections can be represented by relatively high amplitude trough anomalies and should be the focus for selecting drilling locations. It is recognized, however, that gas sands do exist in areas where the seismic character is non descript.

An average pay or potential pay interval within Flat Rock Field is about 12' or about 2 milliseconds. Often, several pays or potential pays lie within one 'zone'. One can envision stacked channel sands formed by a channel remaining in one position over time and being represented by a single trough.

To illustrate the above discussion, refer to Figure 9, "Line 1208". The 32-1A well has 12 feet of gas producing perforations that correspond to the D Zone. In the two adjacent wells, the 32-2A and the 32-7A, seismic amplitudes suggest there should be D Zone pay. Indeed, this was confirmed by detailed analysis of the well data. Although the D Zone sands in the 32-8A well appear to be poorly developed or wet, 'possible' pay is indicated by log analysis. Here, the D Zone trough is not well developed, which is consistent with the analysis of the well data.

Wasatch Zone Maps

The following is a list of additional figures prepared during this interpretation and notable points about each of the following zones is annotated.

Cretaceous Mesaverde: (Figure 12)

- Is an unconformable surface
- The peak above the Mesaverde corresponds well to shaley intervals defined by Dave Allin

Tw-AA: (Figures 13 and 14)

- First sediment package preserved after Mesaverde unconformity
- Limited to east portion of 3D
- Prospective in Section 12

Tw-A: (Figures 15 and 16)

- Present over most of the survey (a transgressive event? Widespread delta?)
- Location in Section 12 is significantly higher structurally than probable pay zones in Flat Rock Field

Tw-A Channel: (Figure 17)

- Isolated channel (?) in southwest portion of field

Tw-A Mesa: (Figures 18 and 19)

- Erosional remnant appears productive in 3 eastern most wells in Flat Rock
- Prospective at both proposed locations
- Del Rio radioactive log marker laid down on top of the Tw-A Mesa package (or Tw-B)

Tw-B: (Figure 20)

- Present in field area only
- Hydrocarbons indicated where trough is present, regardless of amplitude intensity
- Shaley east side of field, confirmed by lithology call in 32-8A.
- Del Rio radio active log marker laid down on top of the Tw-B package (or Tw-A Mesa).

Tw-C: (Figures 21 and 22)

- Similar to B Zone characteristics
- Shaley in 32-11A

Tw-C2: (Figures 23 and 24)

- Lithology inconsistent with seismic character in field area
- Meandering channel trending northeast present in Sec. 11 (proposed location within anomalous amplitude and near closing high contour)

Tw-D: (Figures 25 and 26)

- Eroded (?) by D unconformity on east side of the survey
- Bright amplitude corresponds to perforated zone in 32-1A. Probable pay wells, 32-2A and 32-7A, are also within brighter amplitudes.

Tw -D Unconformity: (Figure 27)

- Mid Wasatch structure on unconformable surface
- Structurally closed extreme west side of survey

Tw-EE: (Figure 28)

- First sediment package deposited after the Tw-D Unconformity
- Isolated body prospective in Section 12.

Tw-E and Tw-E northeast: (Figures 29, 30, and 31)

- Relatively patchy in the western portion of the survey.
- Remnants not cut by later channels, stratigraphically trapped (?)
- Structurally high position in Sec. 12.

Tw-F Channel: (Figure 32)

- Channel cuts into Tw-E

BHR (Base High Resistivity Seismic Marker): (Figure 33)

- Structural configuration near top of Wasatch.
- Note areas of structural closures

INTERPRETATION CONCLUSIONS

DEEP – JURASSIC NAVAJO THROUGH CRETACEOUS MESAVERDE FORMATIONS

The closed structure cresting in Section 9 15S-20E is a high quality seismic anomaly that should be drilled. It is recommended, if funds are available, that a well be drilled on this structure to test the Navajo Formation.

Realizing that the cost of such a test may be considerable, it is recommended that the 3D data volume be processed by another processing company to make sure the closure can be duplicated.

SHALLOW – TERTIARY WASATCH FORMATION

Besides the recommendation to drill the two Wasatch wells, the following observations are offered for consideration.

- Existing Wasatch production in the Flat Rock Field may be partially controlled by down to the south faulting on the north flank of the Hill Creek Anticline. Perusal of the Cretaceous Mesaverde (base of Wasatch) and the Base High Resistivity (near top of Wasatch) structure maps indicate undrilled locations updip and adjacent to existing production. They also indicate a structurally high trend in Sections 11 and 12 of 15S-20E.

- Production in the Flat Rock Field is primarily from rocks below the seismically mapped 'D Unconformity'.

- The presence of anomalous amplitudes in the D Zone package correlates relatively well with indicators of producible hydrocarbons within Flat Rock Field. The high reflection coefficient above this zone may indicate the presence of a regional sealing facies.

- Where the B Zone and C Zone packages are mapped above 0.685 sec., there is an increased probability that producible hydrocarbon reservoir exists.

- The 'A Mesa' (erosional remnant) lies beneath the Base B Unconformity and has indicated pay in three wells on the east side of Flat Rock Field. This zone is present and structurally high at both proposed locations in Sections 11 and 12, 15S-20E.

- Sedimentary features of limited areal extent, like 'Tw-A Channel', are productive. Examination of pressure data could reveal whether or not these apparently small reservoirs are in communication with adjacent reservoirs.

PROPOSED LOCATIONS

Drill site locations were selected by searching for areas where "stacked" amplitude anomalies exist in the Wasatch Formation.

Figures 10 and 11 go together, left to right respectively, to make an "Arbitrary Line from Flat Rock to the Proposed Locations" that shows the relationship between the zones in the field area, across several transform faults, to the structurally high area in Sections 11 and 12. At the Section 11 proposed location, the C-2 Zone, A Mesa Zone, and A Zone appear prospective. The E, EE, and A Mesa, and A Zones are prospective at the Section 12 location. (See the structure and amplitude maps of these zones). The Section 12 location is on a small closure on the Cretaceous Mesaverde Time Structure (Figure 12). The structure appears to continue up dip toward the southeast, off of the current 3D survey. Even though the Mesaverde section appears wet in all of the wells in Flat Rock Field, it would probably be a good idea to test the formation on this structurally high ridge.

OTHER RECOMMENDATIONS:

It would be constructive to compare the logs in the Navajo Sandstone to assess differences in sand development that may be contributing to the difference in amplitude response and may be a consideration when selecting a future deep location.

Only a preliminary analysis of the seismic stratigraphy in the Castlegate and Sego sands was done. A detailed interpretation of that interval would be useful to conduct in the future.

In addition to the primary interpretation effort Wind River and Black Coral entered into a relationship with Landmark Graphics to convert the North Hill Creek data set into Landmark's format and install it on the workstation associated with their newly built 3-D visualization center in Denver. Landmark offered significant free processing and attribute analysis services in exchange for the use of the data set as recent Rocky Mountain area 3-D survey with a broad range of interesting features.

Testing the 3-D Model

The Wasatch Formation anomalies received the greatest interpretation effort during the spring of 2001. Since these were the shallowest targets and would be the least expensive to drill, Wind River decided to test two distinct types of anomalies, as discussed in the technical meeting. A well was staked and permitted in the northwest of Section 11-T15S-R20E to test a large stream channel anomaly called the C2, and several secondary targets. A second well was staked and permitted in the southwest of Section 12. This well was located so as to test several stacked anomalies with apparent four-way closure.

The original schedule was to commence drilling in late June or early July, using a rig that was active in the Flat Rock Field. Due to the remote location and the general unavailability of suitable rigs, borrowing the rig from Del-Rio/Orion was clearly the best choice. Unfortunately, the availability of this rig was delayed into September 2001 by drilling problems associated with the deep well that preceded Wind River's Wasatch tests.

Due to the delay of the drilling Wind River requested and received an extension of the original project deadline so that drilling, completion and production data from the two Wasatch wells could be included in the final report.