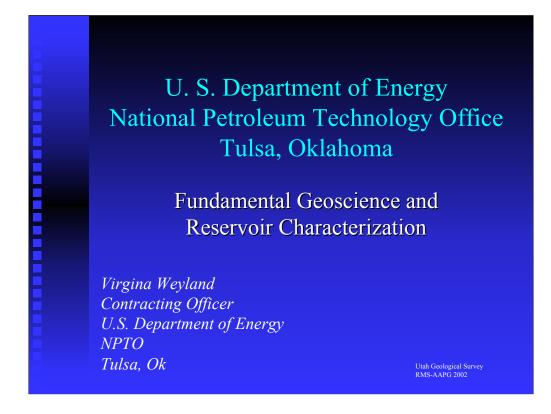
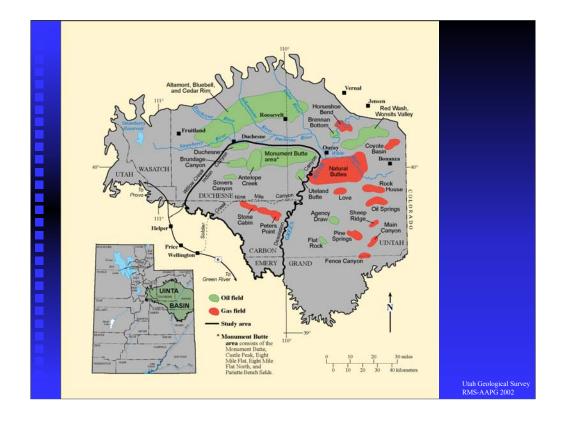


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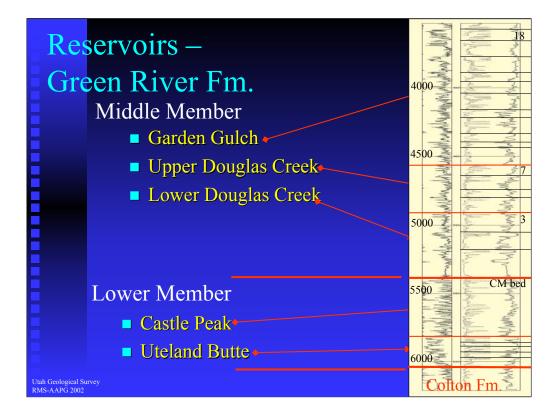


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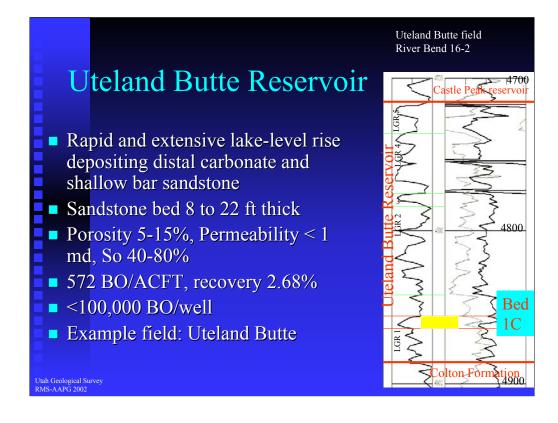
The Uinta Basin is in northeast Utah and is shown in green in the map of the state, the larger map is the outline of the Uinta Basin. Within the basin you see the outline of our study area, many of the maps to follow will be of this area. The north boundary divides the shallow oil production, 4,500- to 6,000-foot lower and middle members of the Green River Formation in the greater Monument Butte – Antelope Creek area, from the deeper (14,000-foot) overpressured, production in the Altamont-Bluebell area from the Flagstaff Member, to the north. The west boundary is formed by Willow Creek and Indian Canyons, the east boundary is formed by the outcrop of the base of the Tertiary.

More than 1,300 wells were correlated, recording 24 log cycles, sandstone and feet of porosity for each log cycle; 32 well cores were examined; and surface exposures of the Green River Formation were examined in Willow Creek, Nine Mile and Desolation Canyons and their tributaries.



The detailed correlation of the log cycles shown by the black lines, were grouped into reservoirs. In stratigraphically ascending order the reservoirs are the Uteland Butte and Castle Peak, in the lower member, and the lower Douglas Creek, the upper Douglas Creek, and the Garden Gulch in the middle member. Oil is produced from the upper member but was not part of this study. The Uteland Butte reservoir is the basal carbonate overlying the Colton Formation. The top of the Castle Peak is defined by the carbonate marker bed, a prominent carbonate bed easily identified on the surface and subsurface throughout the study area. The top of the lower Douglas Creek is defined as the top of the MGR 3 log cycle, the top of the Douglas Creek is the MGR 7 log cycle. MGR 8 - MGR 18 contain the producing beds in the Garden Gulch although there is about 300 feet of additional section between the MGR 18 and the base of the Mahogany oil shale, which is the top of the Garden Gulch Member.

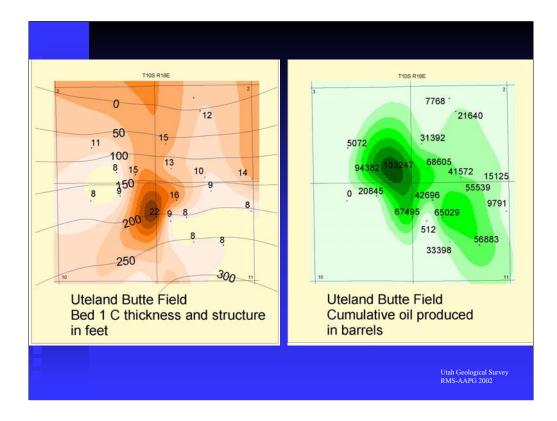
The reservoir designations are not new and are used by many of the operators in the area. But the tectonic and paleodepositional history, petrology, and regional trends that make each of these reservoirs distinct has not been presented in detail before.



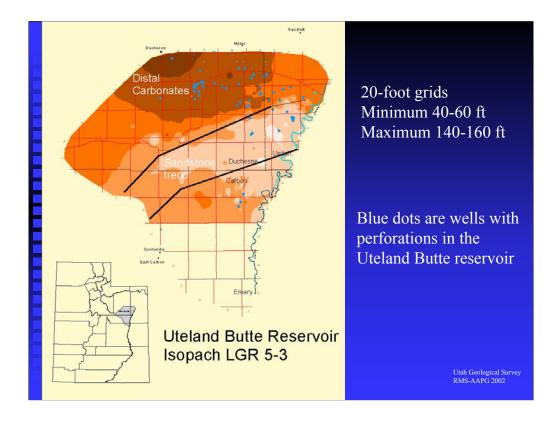
The Uteland Butte reservoir also known as the basal carbonate, was deposited during the first rapid and extensive lake-level rise after deposition of the alluvial Colton Formation. The reservoir is dominately low-permeability carbonate but there are some thin shallow bar sandstone beds. The sandstone has been the primary target in some exploration but the carbonate beds are typically only a secondary objective. The sandstone can range from 8 to 22 feet thick, the average porosity for the entire reservoir is 5 to 15% with < 1 md permeability, average oil saturation of 40 to 80%; the sandstone has slightly better reservoir quality. The Uteland Butte field has 572 BO/ACFT with only a 2.68% recovery. Bed 1C is a productive sandstone bed in the Uteland Butte field.



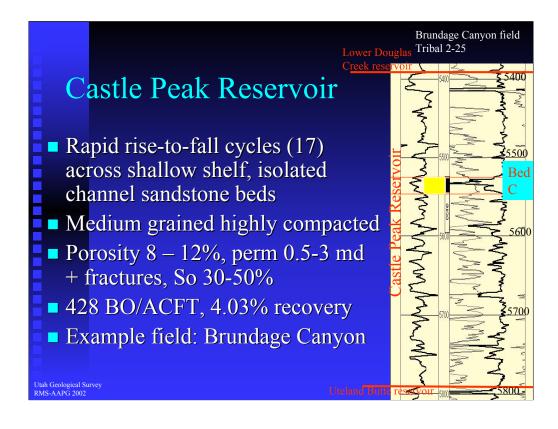
In our study area there was very little siliclastic input during deposition of the Uteland Butte reservoir, this may be because the rising lake level caused sediment to be trapped in the proximal channels or because the major input was south of the San Rafeal Swell, far from the study area, or both. The depositional model from Little (1988) is a passive carbonate shoreline with rare, shallow lacustrine sandstone bars.



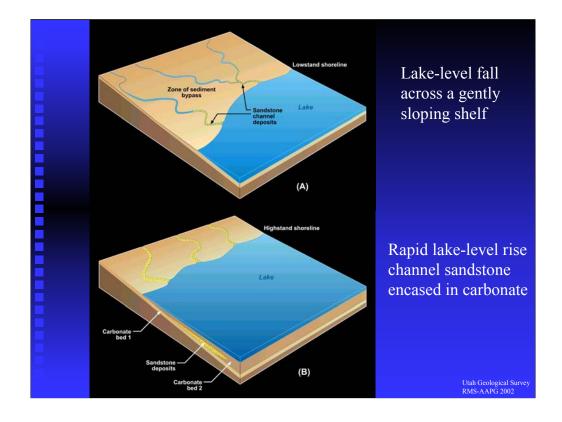
A map of the 1c bed in the Uteland Butte field shows a localized buildup across an regionally dipping structure. Production (only one well exceeds 100,000 BO) does not correlate very well with structure or the sandstone thickness map, this may be a result of the oil contribution from other beds in the Uteland Butte reservoir that were not included in the model. There are still important aspects of this reservoir we do not understand.



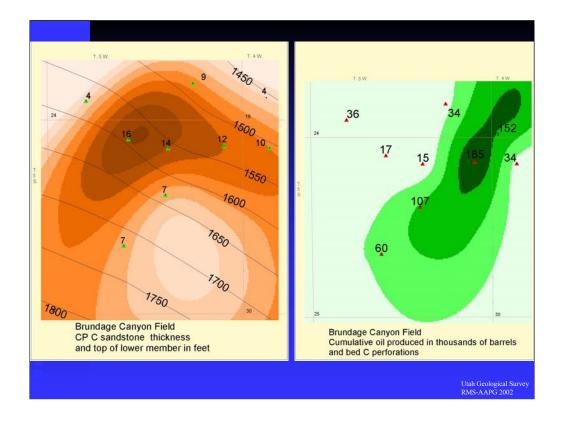
The map shows the thickness trend of the Uteland Butte reservoir. The blue dots represent wells with perforations in the reservoir. The sandstone trend runs from the Uteland Butte field to the Minnie Maude area where thin sandstone beds outcrop but are absent in Willow Creek Canyon the west. The distal carbonates typically have good oil shows, are perforated as secondary objectives and will produce about 30,000 BO/well. The most promising trend as a primary objective is along the sandstone trend.



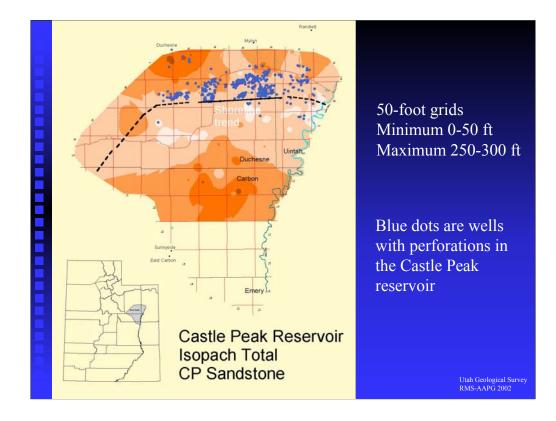
The Castle Peak reservoir overlies the Uteland Butte reservoir and is capped by the carbonate marker bed, a prominent area-wide marker bed in the subsurface and on outcrop. The Castle Peak was not divided into log cycles because the cycles were too thin for reliable regional correlation. The Castle Peak was deposited during a period of very rapid lake-level rise-to-fall cycles across a gently sloping shelf. Hackney and Crouch (2000) identified 17 cycles in the Castle Peak in the Antelope Creek field. This resulted in isolated channel sandstone beds encased in carbonate and shale. The sandstone is typically highly compacted, low porosity of 8-12%, 0.5-3 md, but commonly fractured. The Brundage Canyon model shows the Castle Peak contains 428 BO/ACFT with 4.03% recovery. Bed c is one of the more porous beds in the Brundage Canyon field.



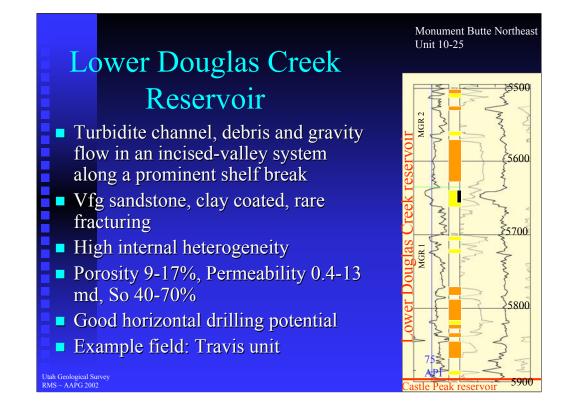
The Castle Peak geologic model consists of lake-level fall across a gently sloping shelf followed by a rapid lake-level rise, as a result only an initial drainage pattern developed, isolated parallel channels. Sand was deposited in the lower reaches of the channels with a zone of sediment bypass higher on the shelf. Sandstone beds in the lowstand shoreline area are encased within carbonate and shale forming vertical and lateral seals. This pattern was repeated 17 times in the Antelope Creek field.



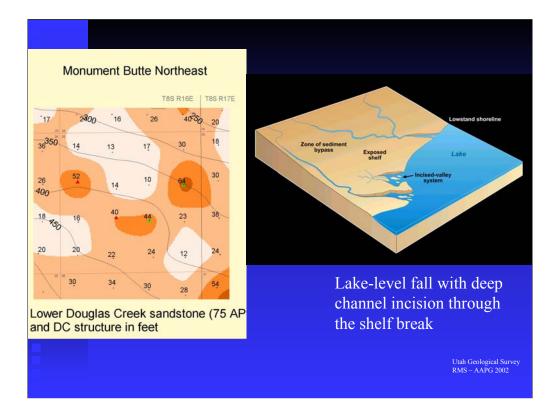
The thickness map of the C sandstone bed in the Brundage Canyon field has a trend very different from the production trend. The green triangles are wells producing from the C sandstone, in this area that includes all of the wells. This is believed to be the result of naturally occurring fractures in the reservoir.



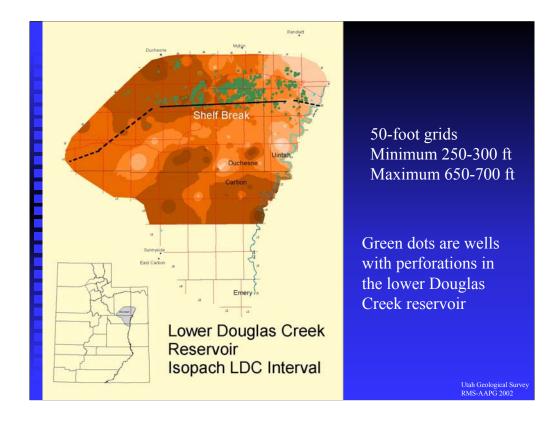
The thickness map of the total sandstone in the Castle Peak reservoir shows a thick to the south where the highstand shorelines were deposited and where a Colton tongue which is included in the isopach, was deposited. Moving basinward, a thin central area followed by the lowstand shoreline trend. The shoreline turns sharply southwest in the west portion of the study area and may be sand poor. The eastern shoreline probably continues but is not as well defined.



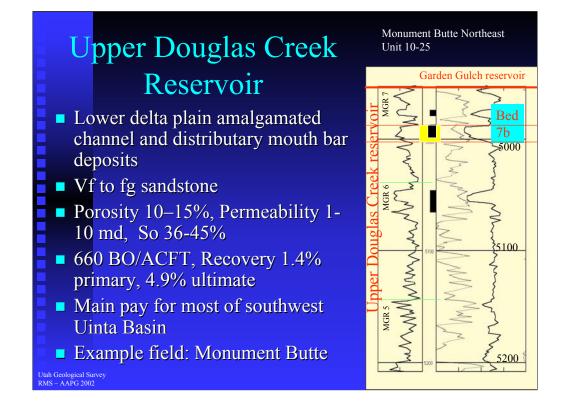
The lower Douglas Creek overlies the Castle Peak reservoir and is the basal reservoir of the middle member. Sue Lutz (1994) described the rocks as turbidite channel, debris and gravity flow. The sandstone is typically very fine grained and clay coated. As a result a sandstone map with a gammaray cut-off, which is how we constructed our regional maps, poorly defines the beds in the reservoir. The yellow on the log are beds with 75 API or less, the orange are sandstone beds with much higher gamma-ray values. The lower Douglas Creek in Desolation and Nine Mile Canyons is composed of the alluvial Renegade Tongue, up to 500 feet thick, with thin interbedded shallow lacustrine deposits. In Willow Creek Canyon the lower Douglas Creek is the classic green shale facies of Picard (1957), but in the greater Monument Butte area the lower Douglas Creek is composed of openlacustrine black dolomitc shale with thick cut-and-fill sandstone deposits. So we have in the proximal region a significant basinward shift of facies but in the distal regional open-lacustrine deposits. A retreat of the shoreline from the proximal region with deepening in the distal regions is caused by deepening of the basin not climatic changes. The lower Douglas Creek was a time of active tectonism in the basin forming a prominent shelf break and resulted in the major in-flow into the lake being directed into the study area. The beds often have a high degree of internal heterogeneity resulting in a wide range of reservoir properties with porosity from 9 to 17%, permeability from 0.4 to 13 md, and oil saturation from 40 to 70%. The reservoir is a good candidate for exploitation with short horizontal laterals from existing well bores because of the abundant oil saturation and high degree of reservoir heterogeniety.



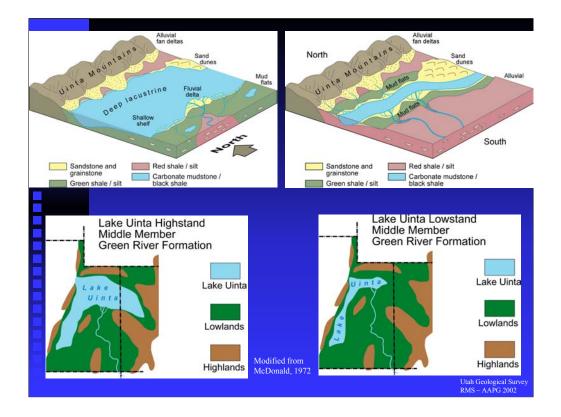
The sandstone map using a 75 API gamma ray cut off poorly defines the reservoir in the Monument Butte Northeast unit. The thick cut-and-fill valleys were developed along a prominent shelf break unlike the gently sloping shelf of the Castle Peak. The shelf break may have been formed by hingeline faults similar to the Duchesne fault zone exposed today at a stratigraphically higher position.



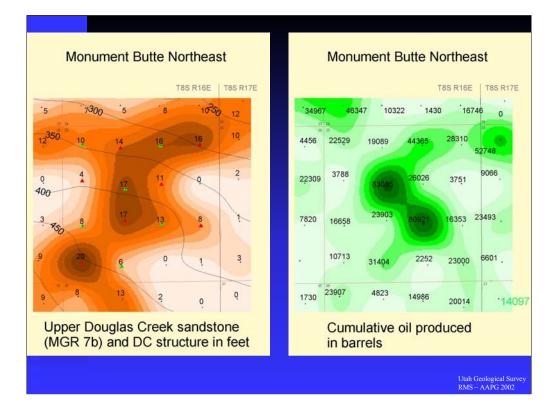
The thickness map of the lower Douglas Creek interval defines the updip limit of the shelf break. The trend turns to the southwest and may not have developed a prominent shelf break, and as a result only thin distributary channel deposits and black shale would be expected. The shelf break may continue to the east, the distal, northern limits of the play are not defined by wells but probably do not extend beyond the study area.



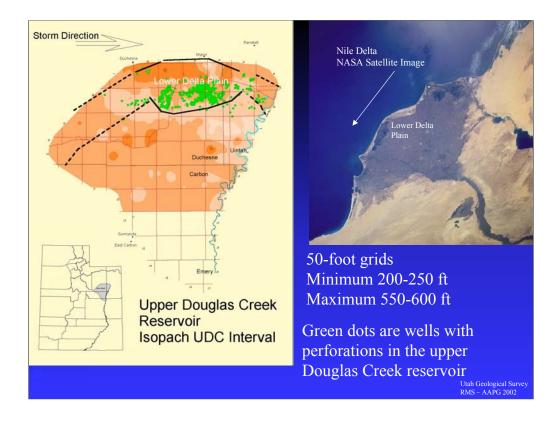
The upper Douglas Creek reservoir is the primary pay in the greater Monument Butte area. The sandstone beds are distributary channel and mouth bars deposited on a lower delta plain. The sandstone beds are often amalgamated and stacked providing several reservoir quality beds. The sandstone is typically very fine to fine grained with 10 to 15% porosity, permeability ranging from 1 to 10 md, and oil saturation from 36 to 45%. The log illustrates three log-cycles MGR 5,6, and 7. MGR 6 and 7 are equivalent to the C and D sands of Lomax/Inland.



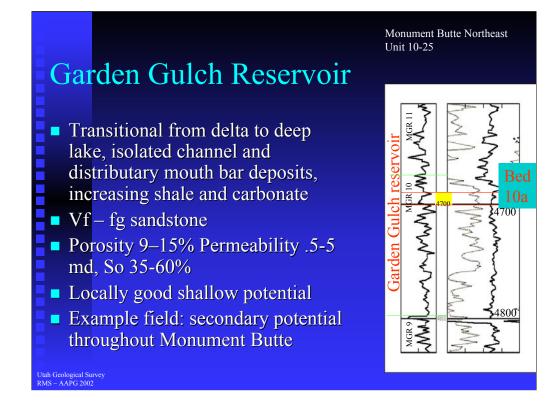
Lake level flucuations resulted in both highstand (exposed in Nine Mile Canyon) and lowstand (Monument Butte area) delta deposits, refered to as the Sunnyside delta by Remy, USGS, 1992.



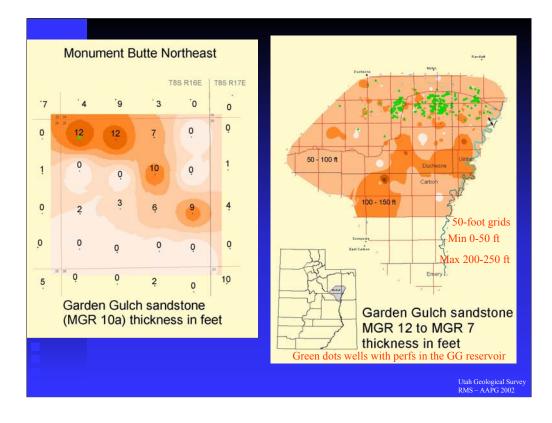
A thickness map of the MGR 7b sandstone shows a SW to NE trend across gently dipping structure. The oil production shows a strong correlation to the sandstone trend. The Monument Butte NE is a water-flood unit, the red triangles are injectors and the green triangles are producers. The wells are drilled on 40 acre centers with an alternating injector-producer pattern, a statistical pattern to exploit numerous beds, but often a poor pattern for any single bed.



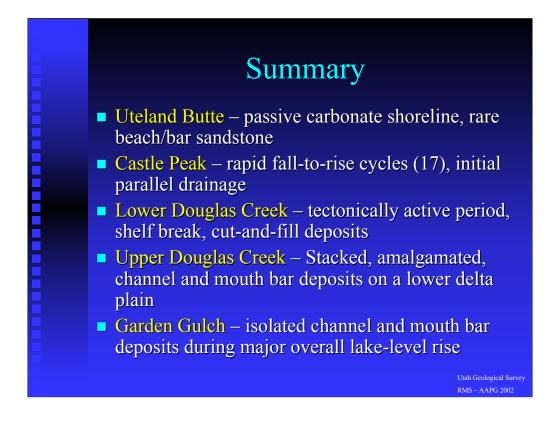
The thickness map of the upper Douglas Creek helps define the play area. The majority of the production lies within the lower delta plain of the lowstand shoreline. To the west of the main delta the shoreline trends southwest. distributary channel and mouth-bar deposits are prospective but are more likely to be isolated non-stacked sandstone beds. To the east of the main delta longshore currents should have resulted in more wave-dominanted deposits which should have good lateral continuity and perhaps improved porosity and permeability. The Nile Delta is a wave-modified fluvial delta in the Mediterranean Sea significantly larger than the deltas in the Green River Formation. But ignoring the marine aspect and the scale, it is an excellent illustration of the depositional setting proposed for the upper Douglas Creek. The satellite image of the Nile Delta shows a fluvial-dominated lower delta plain, up-dip trap formed at transition from lower to upper plain. Long-shore transport from left to right, note increasing sand right to left in the direction of long-shore currents. The same may have occurred during deposition of the upper Douglas Creek.



The Garden Gulch reservoir is a transitional deposit from delta to deep lake culminating in the deposition of the Mahogany oil shale. The sandstone beds are generally isolated individual beds unlike the underlying upper Douglas Creek. Porosity is 9-15%, permeability 0.5 to 5 md, and oil saturation from 35 to 60%. The Garden Gulch is a secondary objective and has not been fully exploited. It is encountered at about 4,200 to 5,000 foot drill depth. The Garden Gulch cyclic depositional pattern is similar to the upper Douglas Creek but with a much higher percentage of carbonate and shale and decreasing sandstone.



An example of a Garden Gulch sandstone in the Monument Butte Northeast unit. The bed has a maximum thickness of 12 feet with a well-defined linear trend. Only one well has perforations in the bed. The Garden Gulch reservoir consists of log cycles MGR 7 to MGR 12 (ascending) gross thickness about 1,000 to 1,200 feet. Regionally the sandstone isopach of all the sandstones in log-cycles MGR 7 to MGR 12 (gross thickness 400 to 500 feet) representing the majority of the Garden Gulch, shows a very nondescript pattern. Most of the wells in the greater Monument Butte area have perforations in one or more beds in the Garden Gulch reservoir.



In summary, the five reservoirs in the lower and middle members of the Green River Formation in the southwest Uinta Basin in ascending order are:

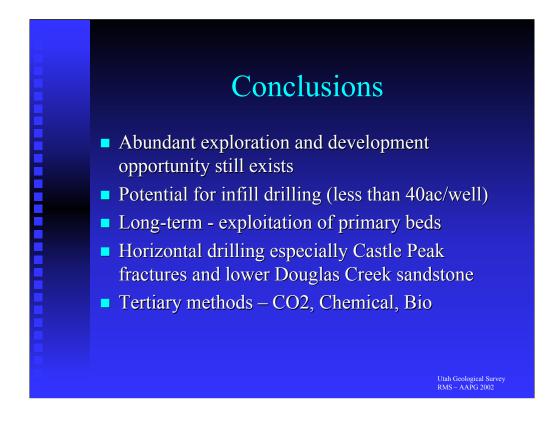
Uteland Butte – passive carbonate shoreline, rare beach/bar sandstone

Castle Peak - rapid fall-to-rise cycles (17), initial parallel drainage

Lower Douglas Creek – tectonically active period, shelf break, cut-and-fill deposits

Upper Douglas Creek – Stacked, amalgamated, channel and mouth bar deposits on a lower delta plain

Garden Gulch – isolated channel and mouth bar deposits during major overall lake-level rise



In conclusion

Abundant exploration and development opportunity still exists

Potential for infill drilling (less than 40ac/well)

Long-term - exploitation of primary beds

Horizontal drilling especially Castle Peak fractures and lower Douglas Creek sandstone

Tertiary methods - CO2, Chemical, Bio