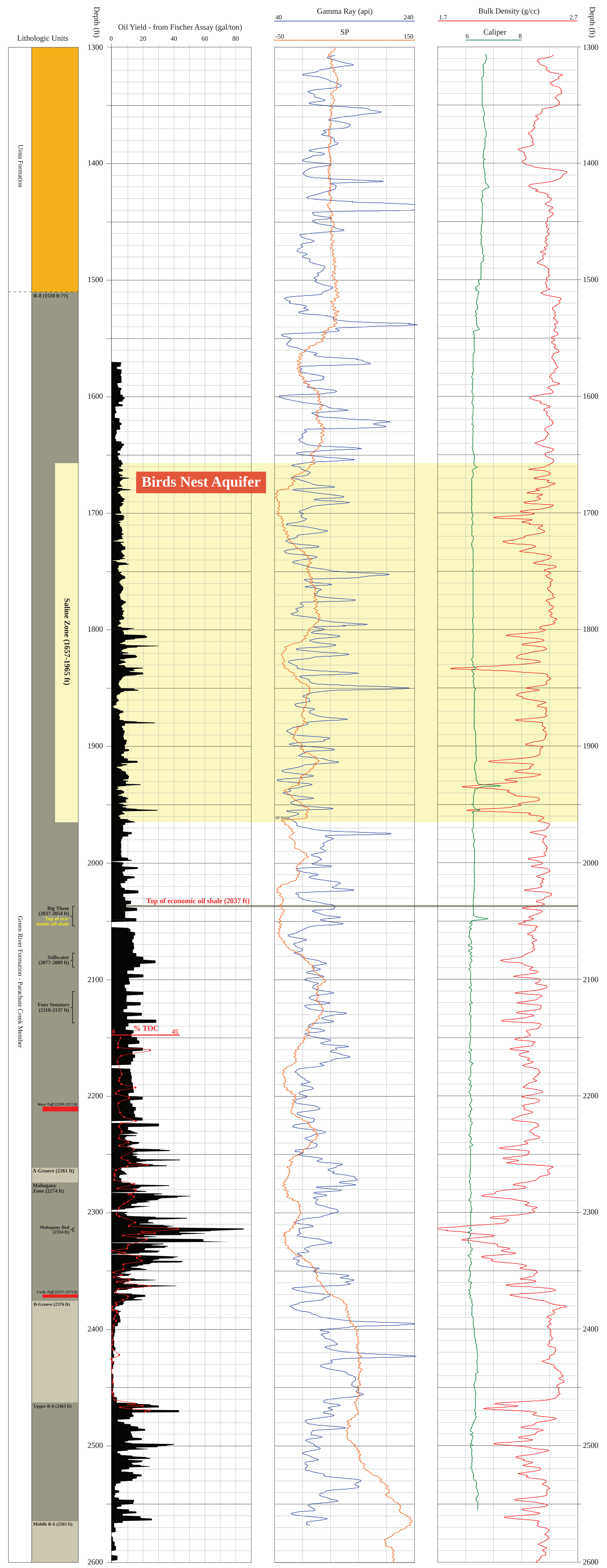
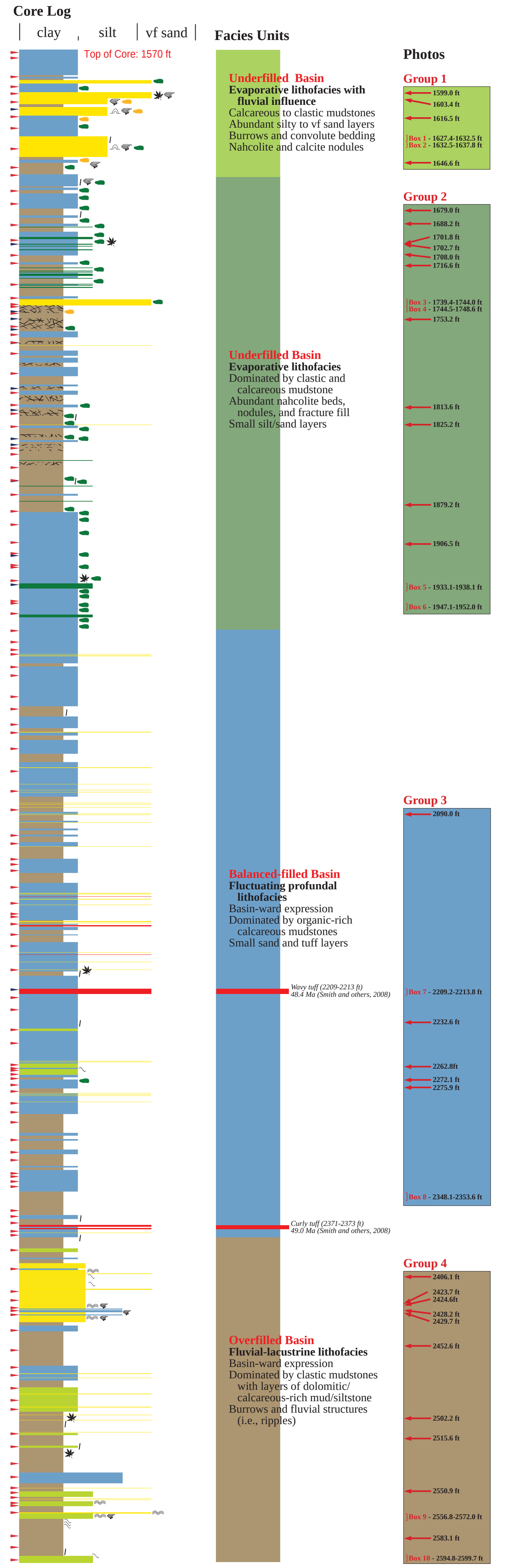
TASK 2: GEOLOGIC EXAMINATION OF THE BIRDS NEST AQUIFER



Well name: Utah State 1
Operator: Tosco Corp.
Location: T9S, R21E, Sec. 26, UTM E 627029, UTM N 4429992
Ground elevation: 4911 ft
Year drilled: 1974
Core housed at the Utah Core Research Center

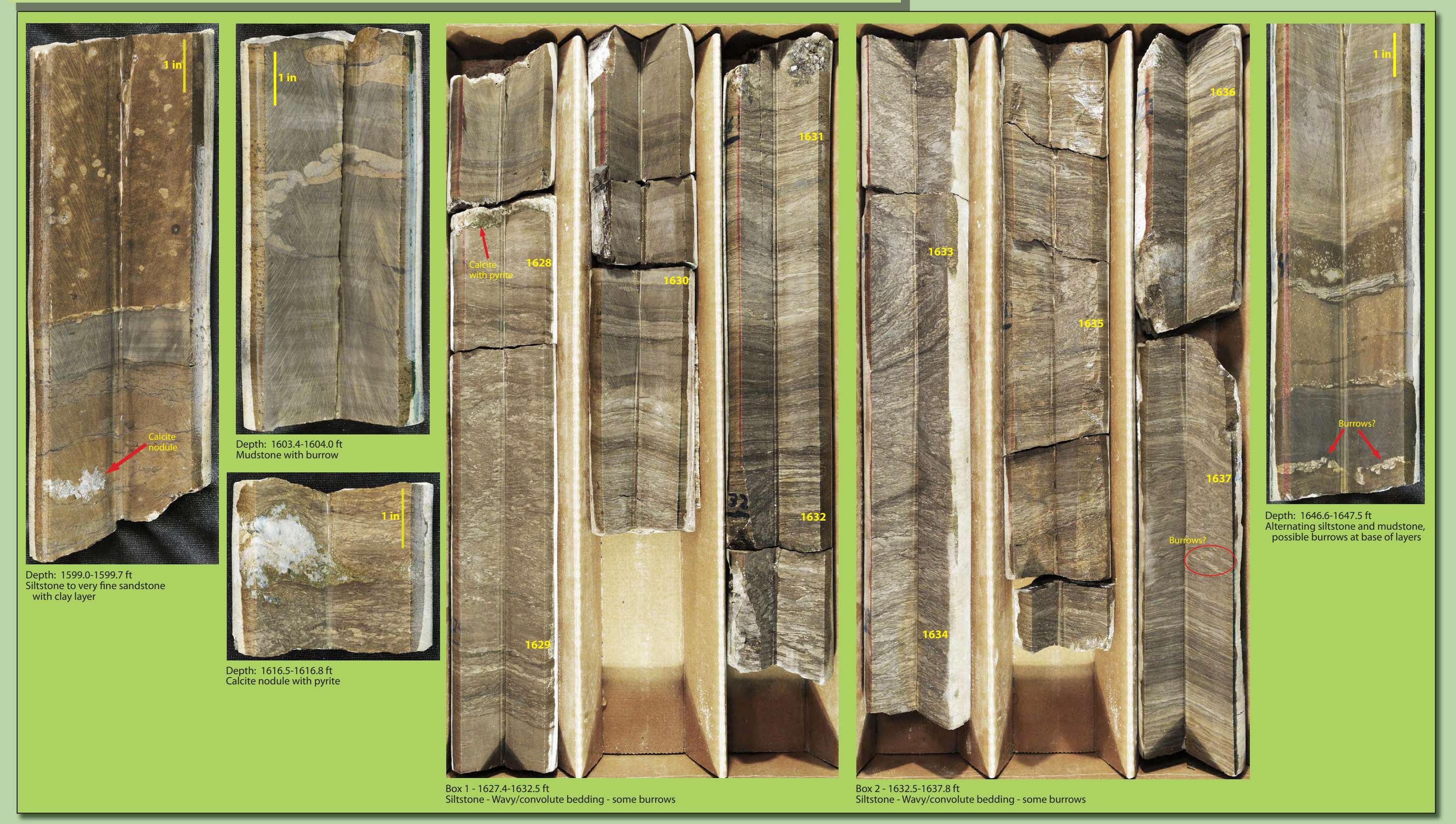
Core Log Key

- Calcareous mudstone - slightly dolomitic
- Siltstone / very fine sandstone - often bitumen stained
- Clay-rich mudstone - slightly calcareous/dolomitic
- Dolomitic mud/siltstone - slightly calcareous
- Nahcolite bed
- Ash / tuff
- Abundant calcite-rich (some nahcolite) fractures
- Sample analyzed with XRF
- Nodule or fracture fill analyzed with XRF
- Nahcolite nodule
- Calcite nodule with pyrite
- Ripples
- Burrows/bioturbation
- Convolute/wavy bedding
- Plant and/or insect material
- Near vertical fracture - often bitumen filled
- Microfault

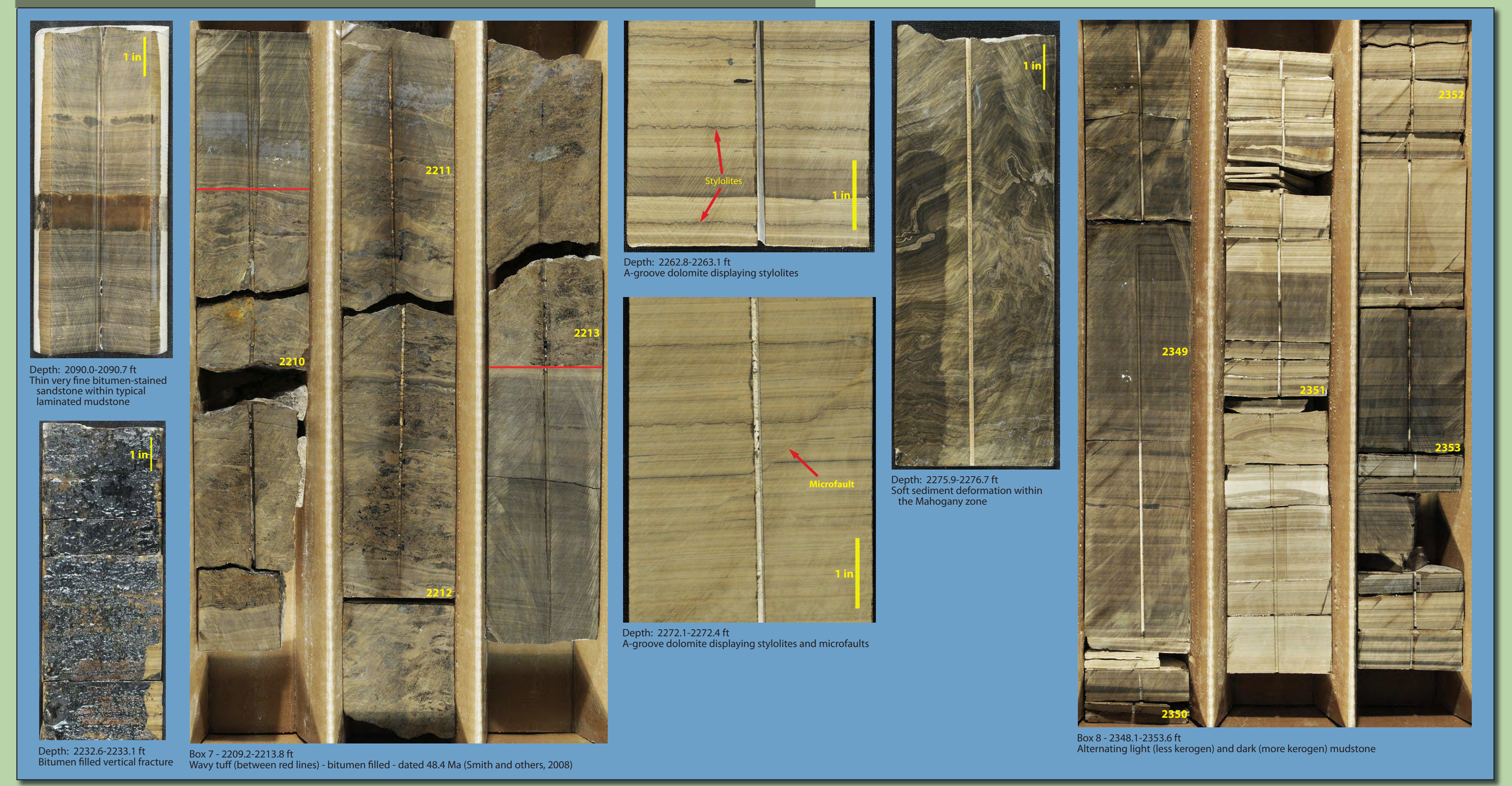


Core Log
clay
silt
vf sand
Facies Units
Photos
Top of Core: 1570 ft
Group 1
Group 2
Group 3
Group 4
Underfilled Basin
Evaporative lithofacies with fluvial influence
Underfilled Basin
Evaporative lithofacies
Balanced-filled Basin
Fluctuating profundal lithofacies
Overfilled Basin
Fluvial-lacustrine lithofacies

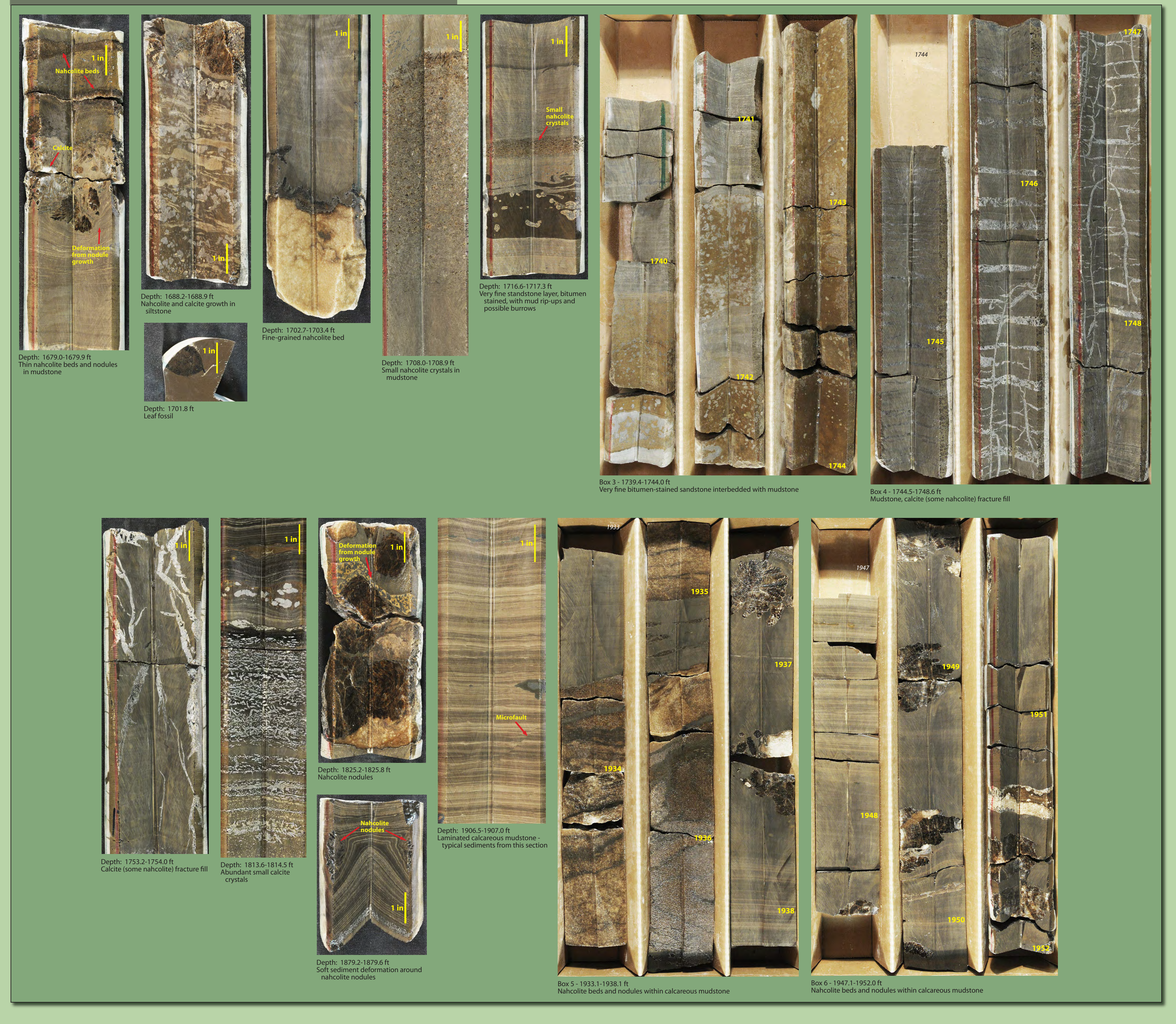
Group 1 - Underfilled Basin - Evaporative lithofacies with fluvial influence



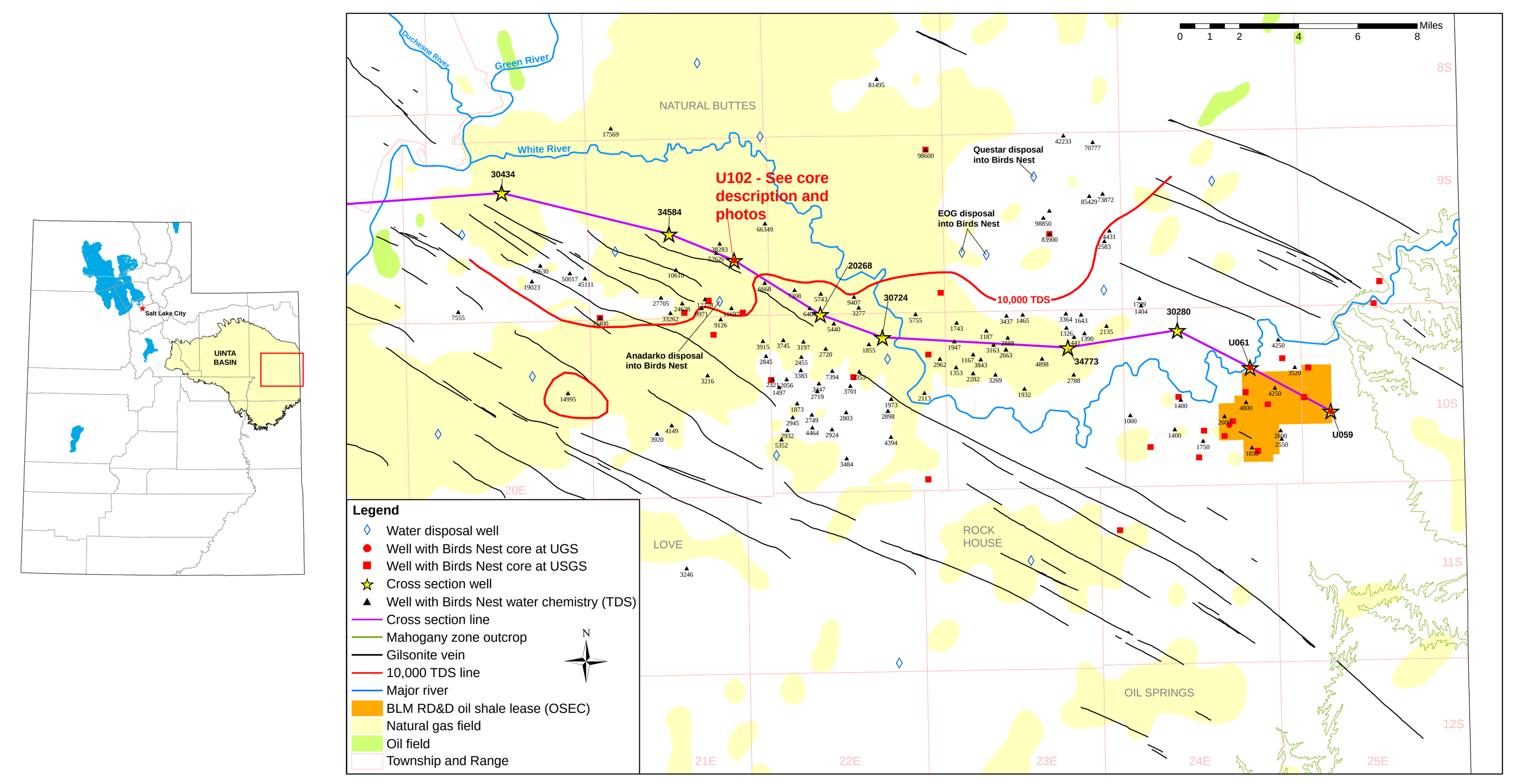
Group 3 - Balanced-filled Basin - Fluctuating profundal lithofacies



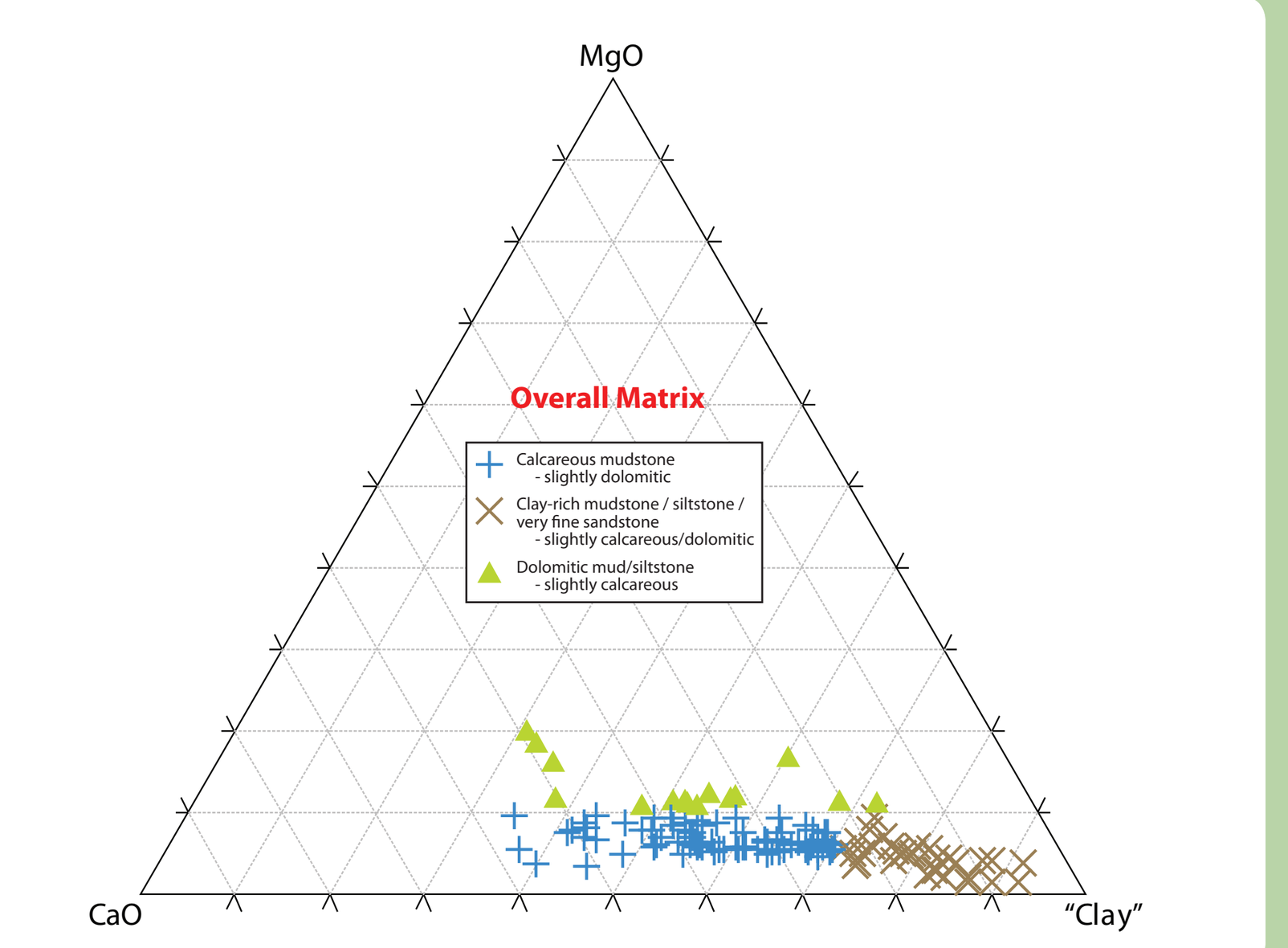
Group 2 - Underfilled Basin - Evaporative lithofacies



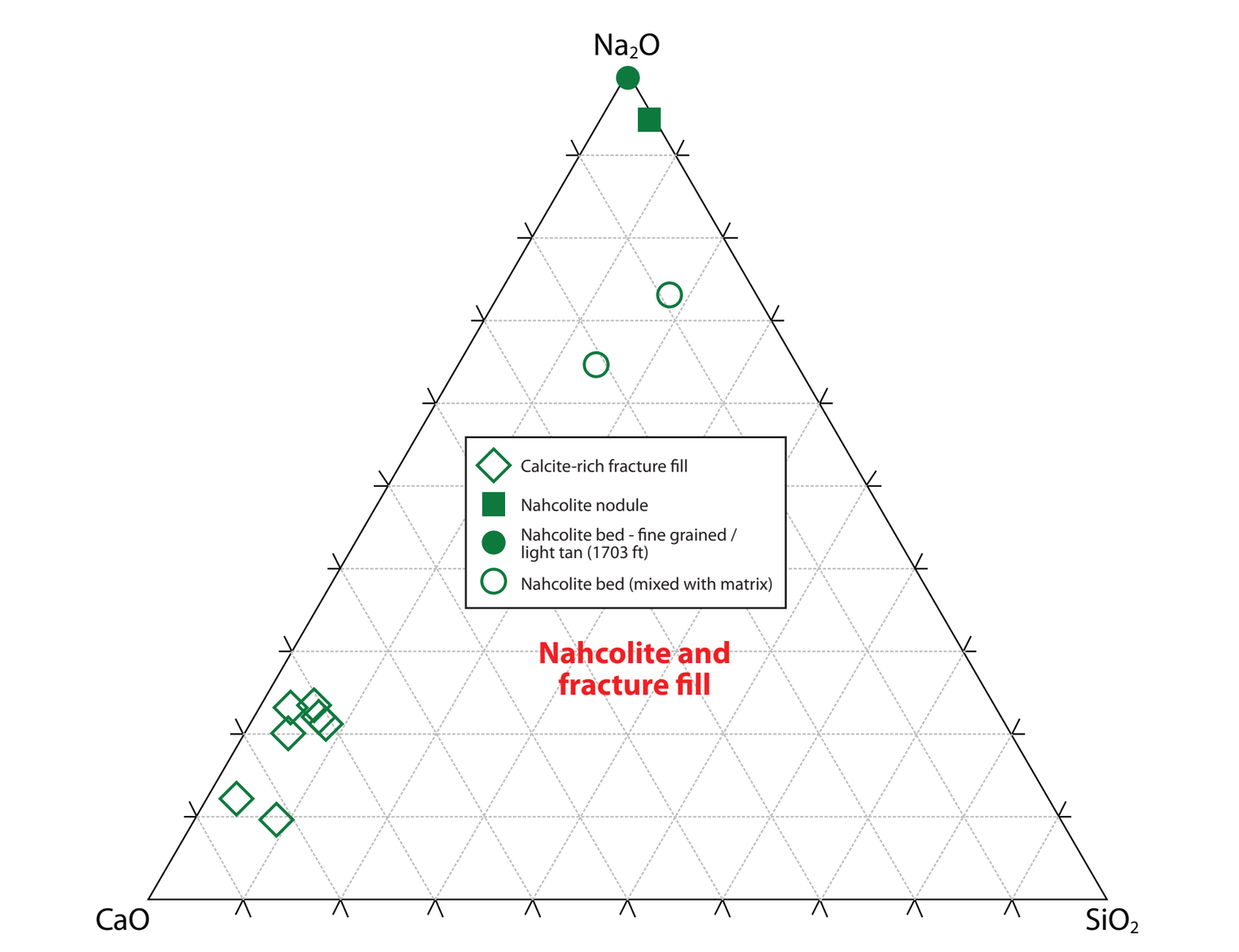
Group 4 - Overfilled Basin - Fluvial-lacustrine lithofacies



The Birds Nest aquifer is mostly isolated to Uintah County with outcrop to the south (yet to be mapped). There is a distinct difference in water chemistry in the north (>10,000 TDS and as high as 100,000 TDS, very saline to briny) than in the south (<10,000 TDS and down to near 1000 TDS, fresh to slightly saline). It is yet unclear why there is such a distinct and dramatic change in chemistry, likely the difference depends on the amount of saline mineral dissolution in the two areas (the southern portion has been flushed clean, while saline minerals in the northern area are still actively dissolving). The presence of nahcolite in the Utah State 1 core demonstrates that there are still zones of no dissolution above the 10,000 TDS line. Anadarko has reported a "zone of lost circulation" (very high porosity and permeability consistent with near complete saline mineral dissolution) near their disposal well in 9S 21E, not far from the Utah State 1 well. Between the two wells is a prominent gilsonite vein that originates in the Mahogany zone and continues up to the surface, cross-cutting the Birds Nest aquifer. These impermeable gilsonite veins may influence groundwater flow patterns in the Birds Nest creating "channels" of dissolution and water flow. We plan to test this theory by looking at several more cores in the area and measuring the amount of saline dissolution.



X-ray fluorescence spectroscopy was used to analyze the elemental composition of the oil shale matrix in 126 samples from the Utah State 1 core (depths identified by little red triangular arrows next to the core log). Analyses were performed on whole rock samples (as opposed to crushed and prepared pellets). This technique was used because it was faster and nondestructive, but yielded a more qualitative result, which still proved very useful in determining overall lithologic composition. Sediments were classified as calcareous mudstones (<70% "clay" [sum of Na, Al, Si, K, and Fe] and >22.5% CaO), clay-rich mudstones (>70% "clay"), and dolomitic mud/siltstones (>10% MgO).



X-ray fluorescence spectroscopy was used to analyze the elemental composition of four nahcolite ($NaHCO_3$) and seven fracture fill samples from the Utah State 1 core (depths identified by little blue triangular arrows next to the core log). The fine-grained tan nahcolite bed (e.g., 1703 ft), as well as a sample of nodular nahcolite, are both relatively pure samples with over 90% Na_2O. The two bedded nahcolite samples contain significant amounts of matrix material bringing their sodium contents down to 53% and 66%. The fracture fill samples show that the dominate mineral is calcite with minor amounts of nahcolite. Since calcite is much less soluble, these fractures probably do not contribute much to the aquifer's overall porosity and permeability, unlike the more soluble nahcolite beds and nodules.