# Markley Submarine Canyon or Something Different?
# A New Eocene Canyon in the Sacramento Basin, Northern California*

**Raymond Sullivan[1] and Morgan D. Sullivan[2]**

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[1]San Francisco State University, San Francisco, California (Sullivan@lucasvalley.net)
[2]Chevron Energy Technology company, Houston, Texas

## Abstract

The Lower Tertiary section in the Sacramento Basin includes several submarine canyons at different stratigraphic levels in the succession. The Markley Submarine Canyon is the youngest and has been dated as Late Eocene/Oligocene age (Almgren, 1978; and Almgren et al., 1988). As mapped, the Markley Submarine Canyon is limited to the central part of the basin. The system is oriented in a north-south direction along the axis of basin for some 45 miles in length and in places is up to 10 miles wide. Filling the deeply incised Markley Submarine Canyon is the Markley Mudstone which is up to 2500 feet in thickness in subsurface. Dominating the canyon-fill are low-density, muddy turbidites. The canyon is deeply incised into submarine fan deposits of the Markley Sandstone of Middle Eocene age and older formations. Several important gas fields are located along the trend of the Markley Canyon.

As part of the present study, a new, previously undescribed submarine canyon has been documented in the southern part of the Sacramento Basin which is older in age but has a similar stratigraphic relationship in the section as the Markley Submarine Canyon to the north. The southern canyon is filled with Sidney Flat Shale of Middle Eocene age and is deeply incised into the underlying Markley Sandstone. The Sidney Flat Shale is made up of 1000 feet of distal muddy turbidites and diatomaceous mudstones in the outcrops on the north flanks of Mount Diablo. The submarine canyon fill reaches a maximum thickness of 1500 feet in the subsurface. It is oriented in a general north-south direction and can be traced for a distance of about 15 miles along the axis of the basin.

At least five mudstone-filled submarine canyons are now recognized in the Lower Tertiary section in the Sacramento basin. These mudstone-filled submarine canyons are vertically stacked similarly to the Eocene fluvial/estuarine incised valley systems previous documented (Sullivan and Sullivan, 2012). The locations of these depositional systems are interpreted to have been controlled by tectonic subsidence due to their vertical stacking along the Sacramento Basin axis. The timing of the submarine canyons and also the fluvial/estuarine incised valley systems

appear to have been eustatically controlled based on the strong correlation between the ages of sediment filling relative to the worldwide coastal onlap curve. This suggests tectonics controlled the location of these deeply incised systems, both on the shelf and upper slope, but eustacy controlled the timing of incision, even in this clearly tectonically active basin. This has important implications for predicting where and when deeply incised canyons and valleys maybe have formed in similar depositional settings.

## Selected References


Almgren, A.A., 1984, Timing of Submarine Canyon and Marine Cycles of Deposition in the Southern Sacramento Valley, California, *in* A.A. Almgren and P.D. Hacker (eds.), Paleogene submarine canyons of the Sacramento Valley, Califoirnia: Pacific section, AAPG, p. 1-16.

Almgren, A.A., M.V. Filewicz, and H.L. Heitman, 1988, Lower Tertiary Foraminiferal and calcareous Nannofossil zonation of California, *in* M.V. Filewicz and R.I. Squires (eds.), Paleogene Stratigraphy, West Coast of North America: Pacific Section, SEPM, p. 83-105.

Sullivan, R., and M.D. Sullivan, 2012, Sequence Stratigraphy and Incised Valley Architecture of the Domengine Formation, Black Diamond Mines Regional Preserve and the Southern Sacramento Basin, California, U.S.A.: Journal of Sedimentary Research, v. 82, p.781-800.

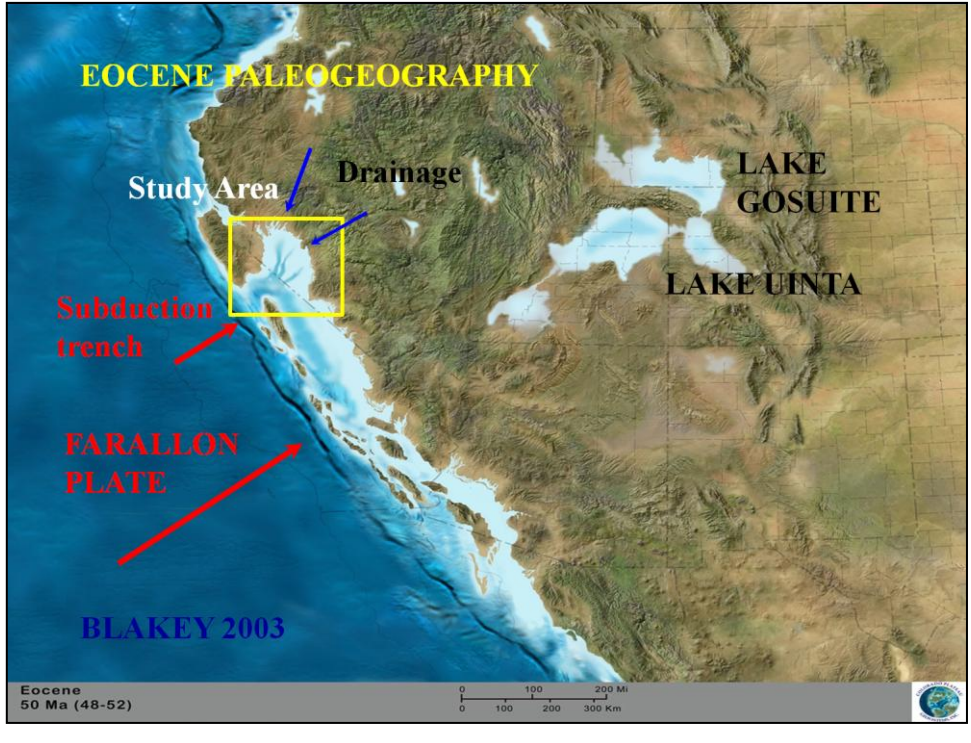
# MARKLEY SUBMARINE CANYON OR SOMETHING DIFFERENT?

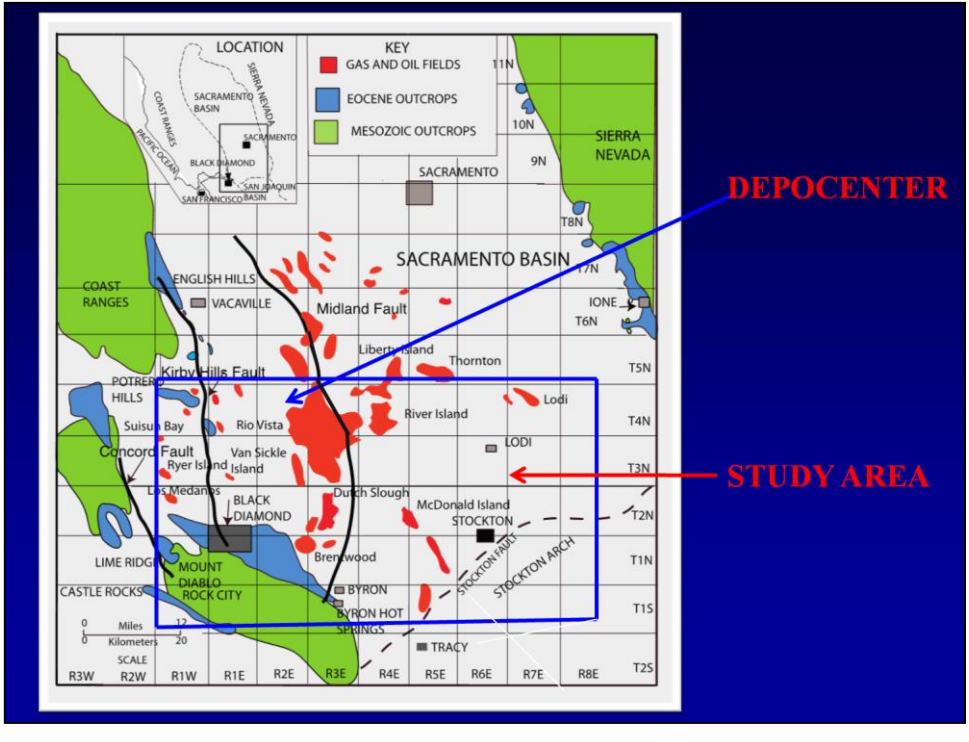
## A new middle Eocene Canyon in the Sacramento Basin

RAY SULLIVAN, San Francisco State University
MORGAN SULLIVAN, Chevron, Houston

# OBJECTIVES

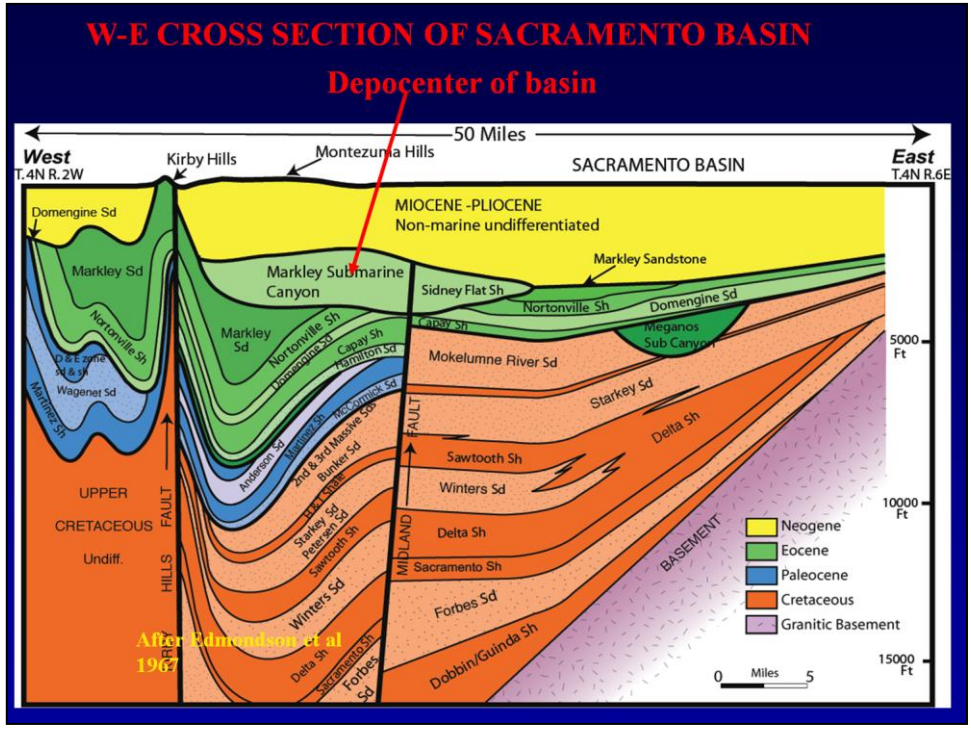
- Better understand paleogeography and drainage systems of the Sacramento Basin in middle and late Eocene to early Oligocene times
- Integrate the outcrops on the north flanks of Mt Diablo w/ the subsurface of the Sacramento Basin
- Investigate the
  - age and relationship of the Markley Submarine Canyon
  - marine depositional cyclicity in the Sacramento Basin

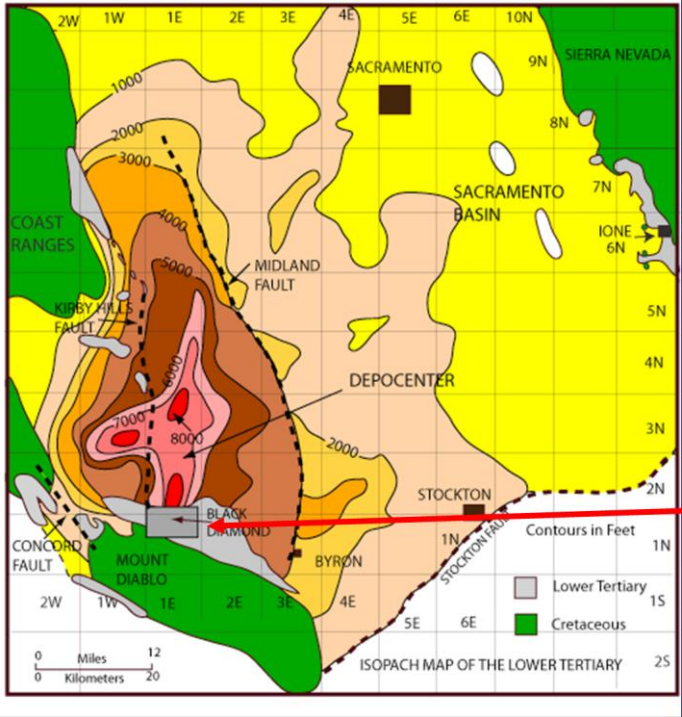

EOCENE PALEOGEOGRAPHY
Study Area
Drainage
LAKE
GOSUITE
LAKE UINTA
Subduction
trench
FARALLON
PLATE
BLAKEY 2003
Eocene
50 Ma (48-52)
0 100 200 Mi
0 100 200 300 Km




DEPOCENTER

STUDY AREA

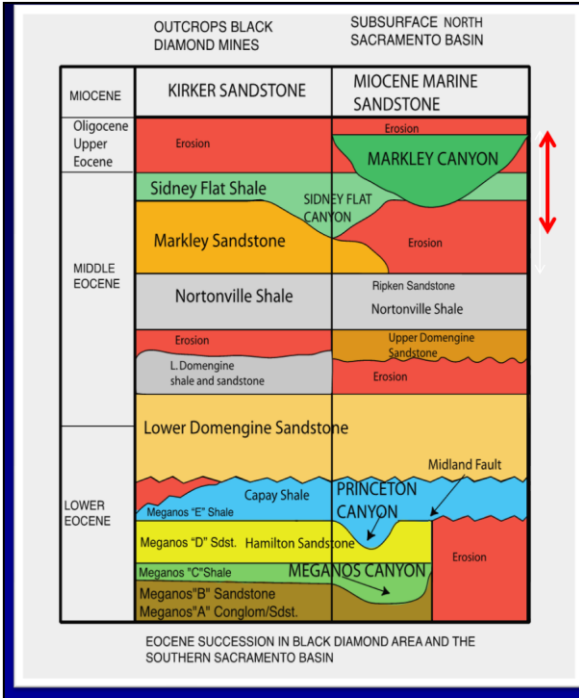

W-E CROSS SECTION OF SACRAMENTO BASIN
Depocenter of basin
50 Miles
West
T.4N R. 2W
Kirby Hills
Montezuma Hills
SACRAMENTO BASIN
East
T.4N R.6E
MIOCENE -PLIOCENE
Non-marine undifferentiated
Markley Sandstone
Markley Submarine Canyon
Sidney Flat Sh
Nortonville Sh
Domengine Sd
Capay Sh
Meganos Sub Canyon
Mokelumne River Sd
Starkey Sd
Delta Sh
Sawtooth Sh
Winters Sd
Delta Sh
Sacramento Sh
Forbes Sd
Dobbin/Guinda Sh
BASEMENT
FAULT
MIDLAND
Domengine Sd
Markley Sd
Nortonville Sh
D & E zone Sd & Sh
Wagener Sd
Martinez Sh
UPPER CRETACEOUS Undiff.
HILLS FAULT
Hamilton Sd
Mococmick Sd
Martinez Sh
Anderson Sd
2nd & 3rd Massive Sd
Bunker Sd
D & E Shale
Starkey Sd
Petersen Sd
Sawtooth Sh
Winters Sd
Delta Sh
Sacramento Sh
Forbes Sd
5000 Ft
10000 Ft
15000 Ft
Neogene
Eocene
Paleocene
Cretaceous
Granitic Basement
0 Miles 5
After Edmondson et al 1967




**ISOPACH MAP OF THE LOWER TERTIARY IN SACRAMENTO BASIN**

**8000 feet of lower Tertiary Sacramento Basin**

**Black Diamond located in depocenter**

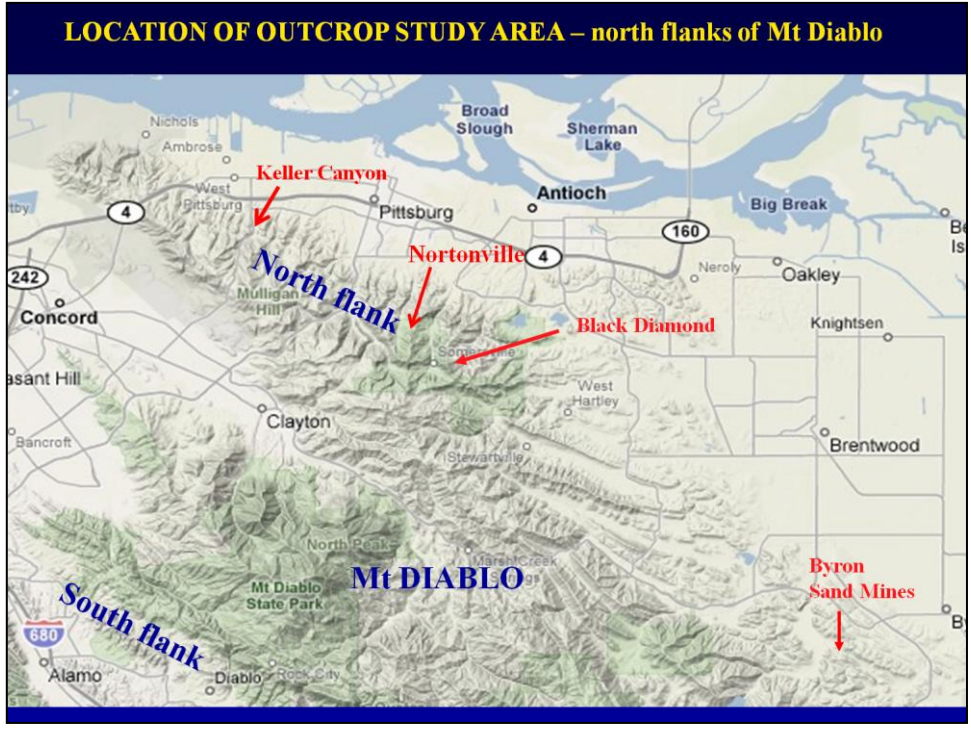



EOCENE SUCCESSION IN BLACK DIAMOND AREA AND THE SOUTHERN SACRAMENTO BASIN

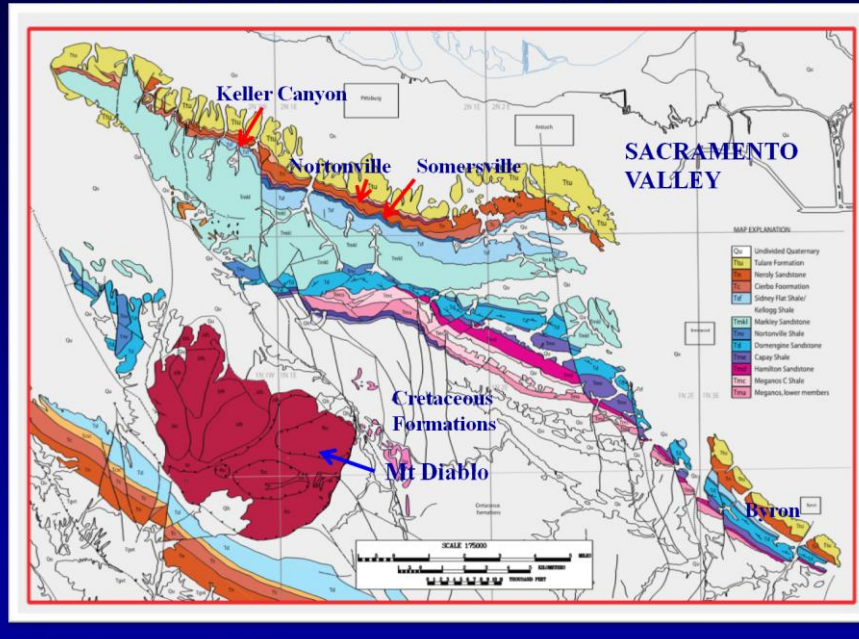
# EOCENE SEQUENCES

**Section in this Study**

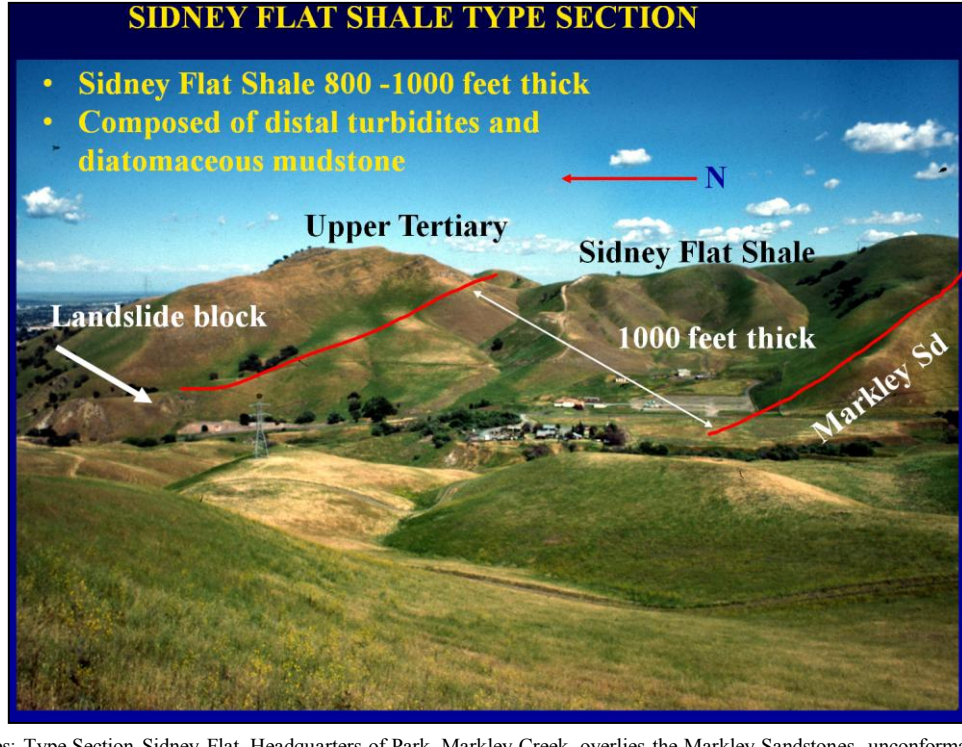
**Relationship of the Markley Canyon and Sidney Flat Shale**


LOCATION OF OUTCROP STUDY AREA – north flanks of Mt Diablo
Broad Slough
Sherman Lake
Nichols
Ambrose
Keller Canyon
West Pittsburg
Pittsburg
Antioch
Big Break
4
160
242
Nortonville
North flank
Neroly
Oakley
Mulligan Hill
Concord
Black Diamond
Knightsen
Somersville
West Hartley
Clayton
Brentwood
Bancroft
Stewartville
North Peak
Marsh Creek
Mt DIABLO
Mt Diablo State Park
Byron Sand Mines
South flank
680
Alamo
Diablo
Rock City

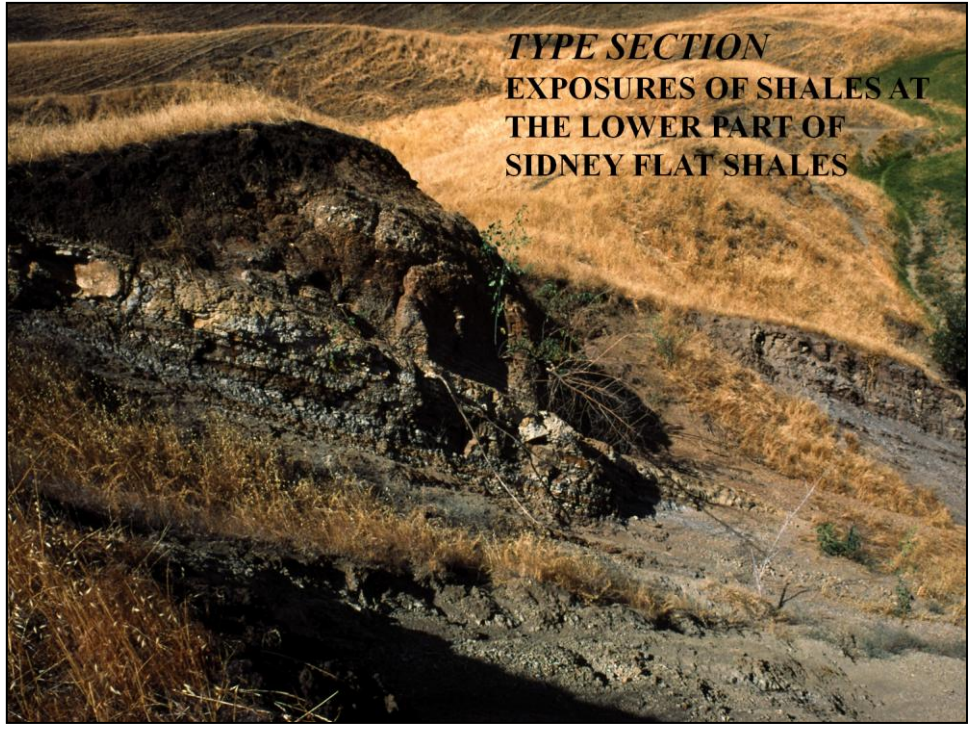
# GEOLOGICAL MAP OF CONTRA COSTA COUNTY

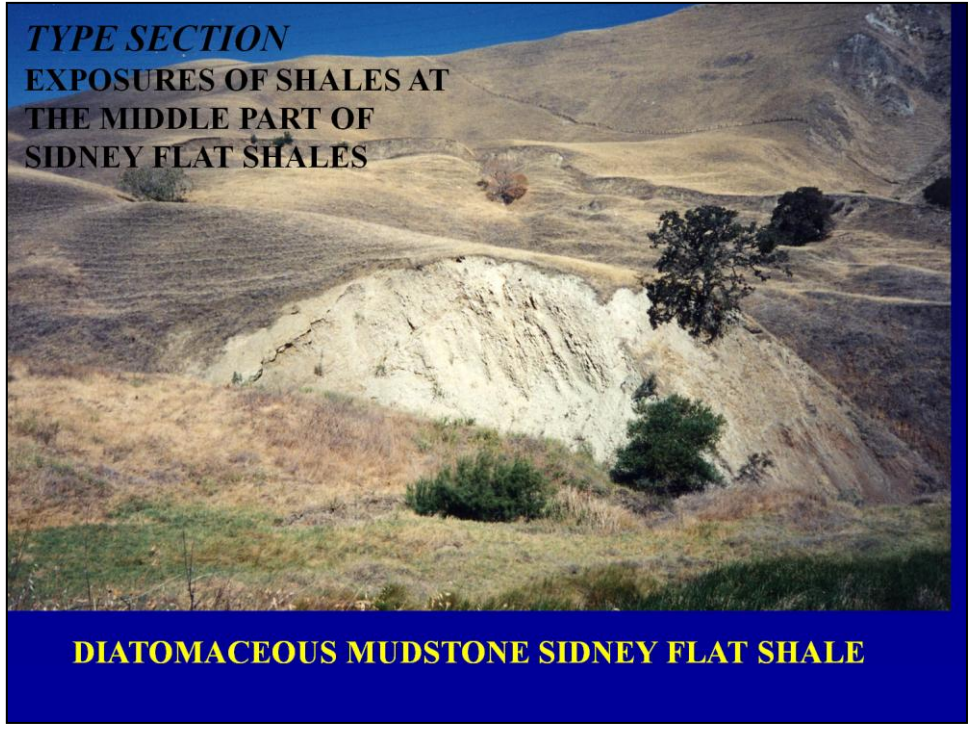


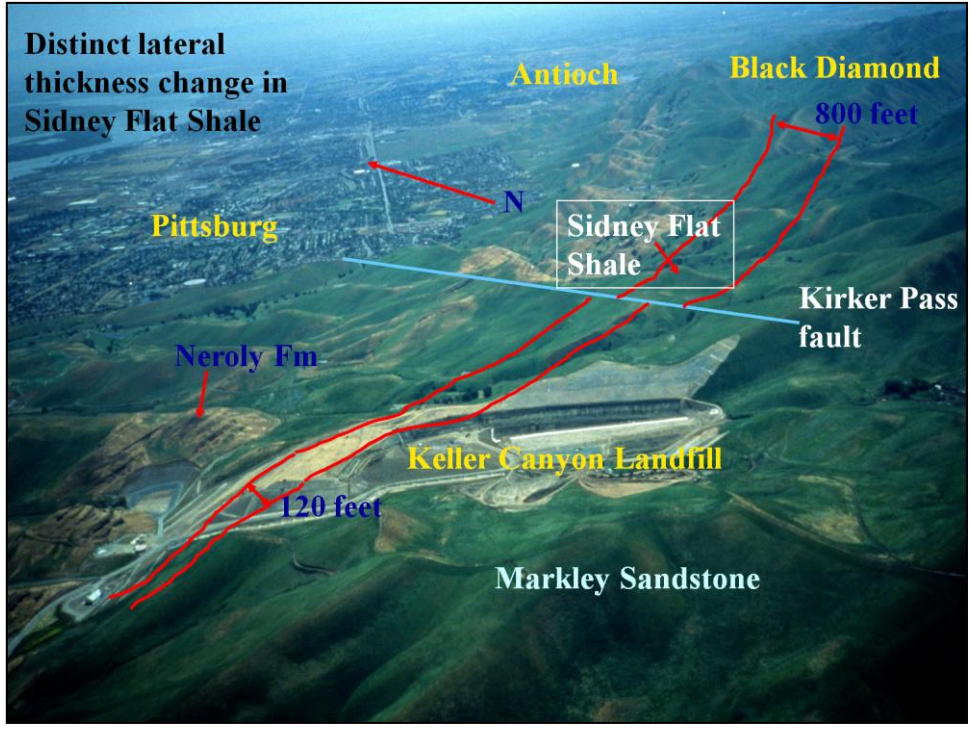

After Graymer et al. 1994



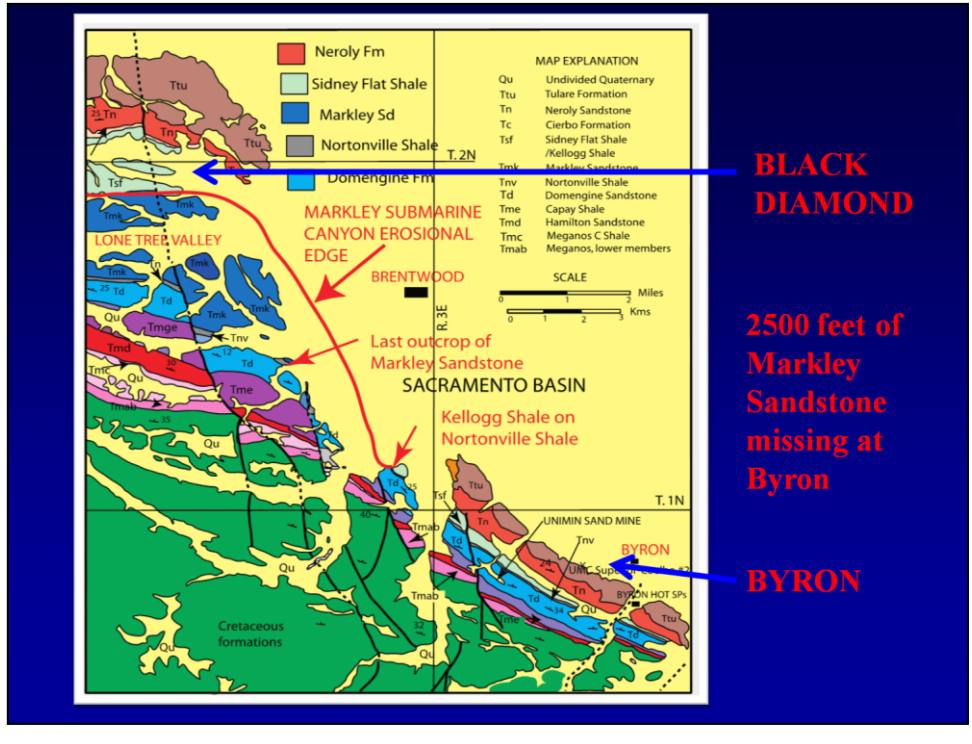

Presenter's notes: Type Section Sidney Flat. Headquarters of Park, Markley Creek, overlies the Markley Sandstones, unconformably overlain by U Tertiary. Diatomacoues mudstone forms ridge in middle of the shale unit. Landslide block of U. Tertiary is the U. Markley Sd.


*TYPE SECTION*
EXPOSURES OF SHALES AT
THE LOWER PART OF
SIDNEY FLAT SHALES

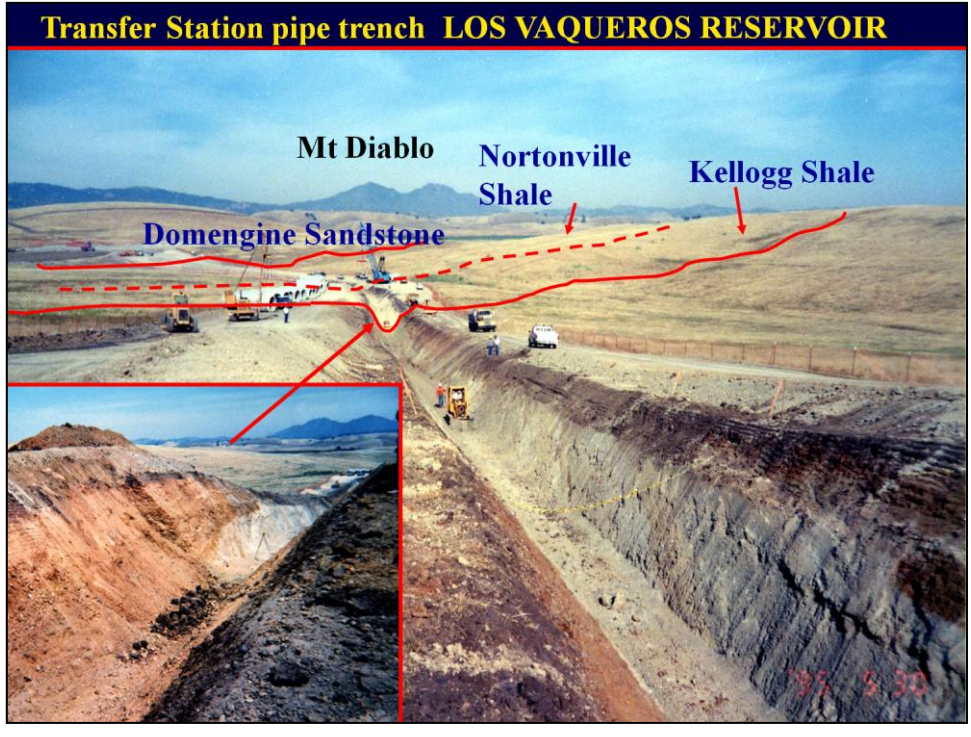

*TYPE SECTION*
EXPOSURES OF SHALES AT
THE MIDDLE PART OF
SIDNEY FLAT SHALES
DIATOMACEOUS MUDSTONE SIDNEY FLAT SHALE



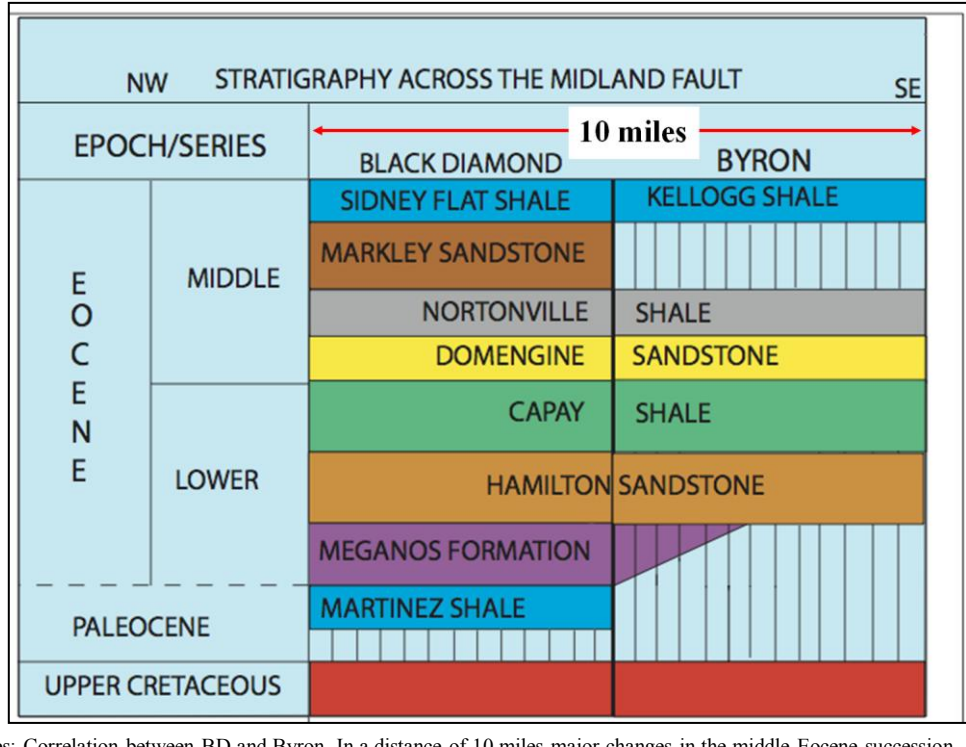

Presenter's notes: View east along the strike ridges of the Tertiary between Keller Canyon and BD. North are the towns of Antioch and Pittsburg. Keller Canyon landfill Is labeled as well as the N-S Kirker Pass fault. The upper Tertiary stands out as a prominent W-E ridge, the Neroly volcaniclastic sandstones are easily traceable. The landfill is within the Markley Sandstone. The Sidney Flat Shale thickens eastward.


Neroly Fm
Sidney Flat Shale
Markley Sd
Nortonville Shale
Domengine Fm
MAP EXPLANATION
Qu Undivided Quaternary
Ttu Tulare Formation
Tn Neroly Sandstone
Tc Cierbo Formation
Tsf Sidney Flat Shale /Kellogg Shale
Tmk Markley Sandstone
Tnv Nortonville Shale
Td Domengine Sandstone
Tme Capay Shale
Tmd Hamilton Sandstone
Tmc Meganos C Shale
Tmab Meganos, lower members
SCALE
Miles
Kms
T. 2N
T. 1N
R.3E
BLACK DIAMOND
MARKLEY SUBMARINE CANYON EROSIONAL EDGE
LONE TREE VALLEY
BRENTWOOD
Last outcrop of Markley Sandstone
SACRAMENTO BASIN
Kellogg Shale on Nortonville Shale
UNIMIN SAND MINE
BYRON
BYRON HOT SPs
Cretaceous formations
2500 feet of Markley Sandstone missing at Byron
BYRON

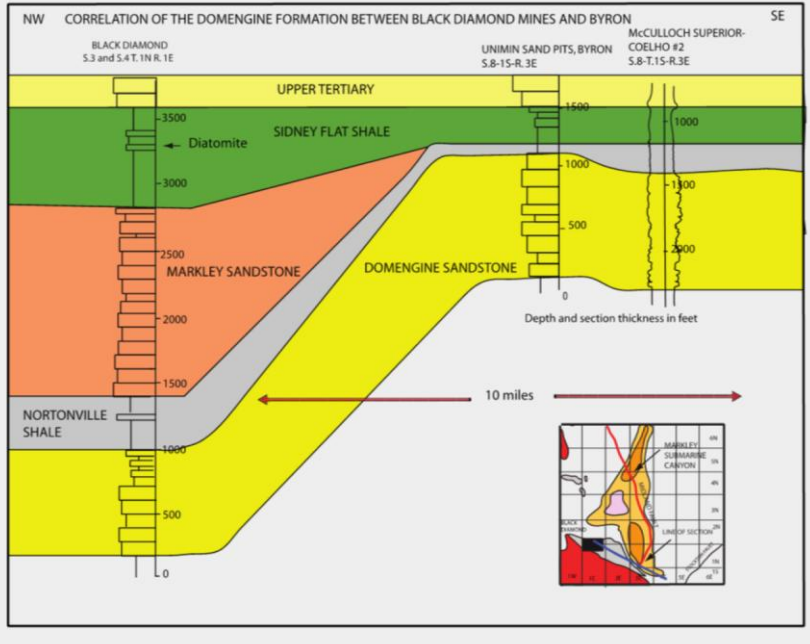

Presenter's notes: Byron sand mines of the Gallo Co. Domengine Sandstone has thickened to a 1000 feet. In contrast the Markley Sandstone Is absent. What is the stratigraphic explanation? Clearly an unconformity at the base of the Sidney Flat - relationship not evident at BD.




Presenter's notes: Looking west to Mt Diablo. Transfer station pipe line excavation for the Los Vaqueros reservoir. Exposed the stratigraphic section showingi Neroly blue volcaniclastic sandstone in foreground overlying Kellogg Shale. In the distance Nortonville Shale and Domengine Sd.




Presenter's notes: Correlation between BD and Byron. In a distance of 10 miles major changes in the middle Eocene succession. 2500 feet of Markley Sandstone is gone. Sidney Flat Shale can be correlated to Kellogg Shale

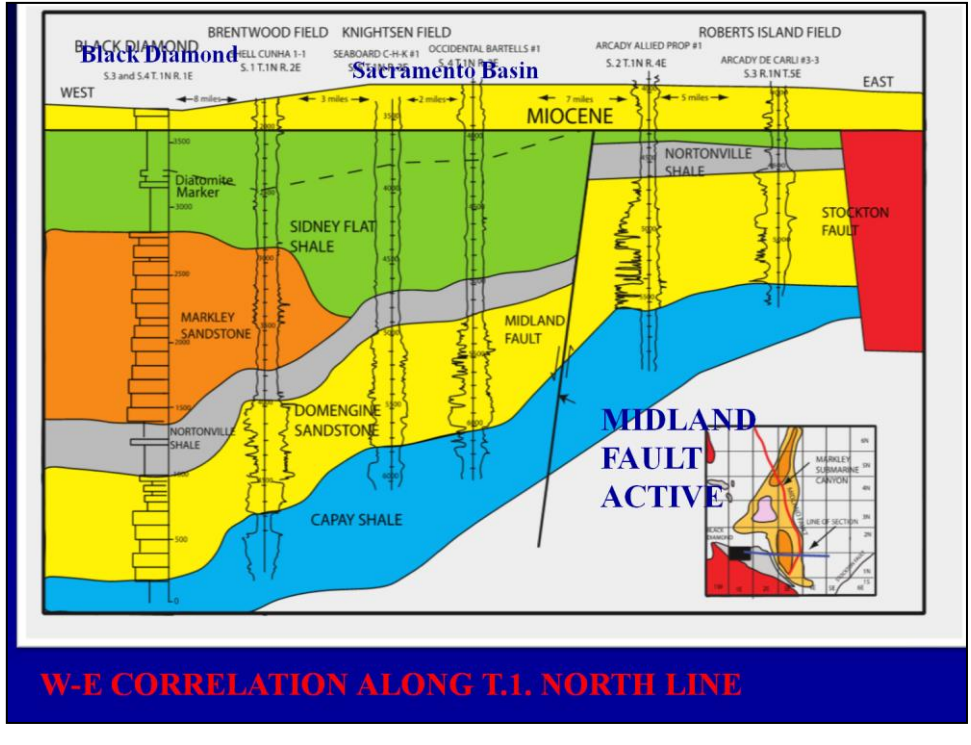

NW
CORRELATION OF THE DOMENGINE FORMATION BETWEEN BLACK DIAMOND MINES AND BYRON
SE
BLACK DIAMOND
S.3 and S.4 T. 1N R. 1E
UNIMIN SAND PITS, BYRON
S.8-1S-R.3E
McCULLOCH SUPERIOR-
COELHO #2
S.8-T.1S-R.3E
UPPER TERTIARY
SIDNEY FLAT SHALE
Diatomite
MARKLEY SANDSTONE
DOMENGINE SANDSTONE
NORTONVILLE
SHALE
3500
3000
2500
2000
1500
1000
500
0
1500
1000
500
0
1000
2000
Depth and section thickness in feet
10 miles
MARKLEY
SUBMARINE
CANYON
LINE OF SECTION

# SIDNEY FLAT SHALE

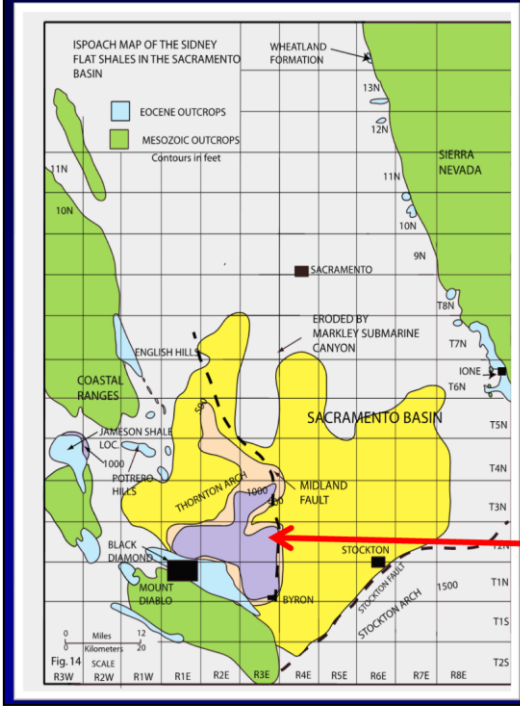
- The stratigraphic relationship at Byron and subsurface supports placing the Sidney Flat Shale in a submarine canyon.
- Sidney Flat Shale incised into Markley Sandstone
- Most thick shale sequences in the Lower Tertiary of the basin fill submarine canyons
- Includes Martinez, Meganos, Princeton, and Markley canyons

# SIDNEY FLAT SHALE

- Widespread in the subsurface of the basin
- Greatest thickness in the south of the basin where it occupies a submarine canyon
- Paleontology shows that the Sidney Flat Shale is middle Eocene age
- Deposited at bathyal depths



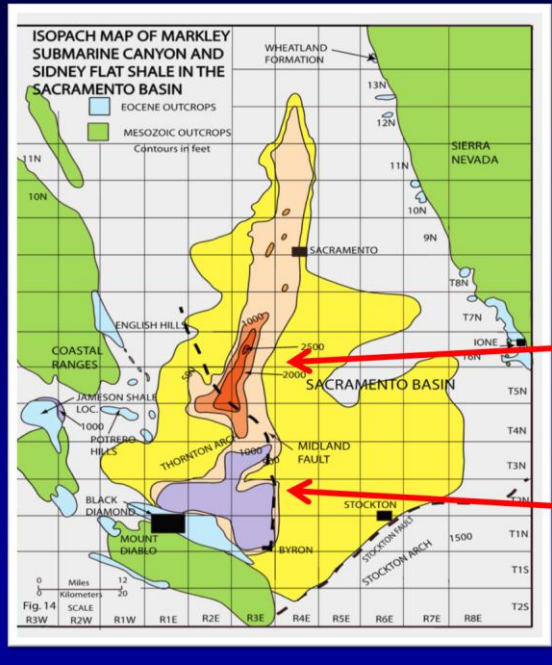

**W-E CORRELATION ALONG T.1. NORTH LINE**




**ISOPACH MAP OF THE SIDNEY FLAT SHALE**

**LOCATED IN SOUTH OF BASIN**

**SUBMARINE CANYON**




# ISOPACH MAP OF THE MARKLEY CANYON AND SIDNEY FLAT SHALE

MARKLEY CANYON

SIDNEY FLAT SHALE

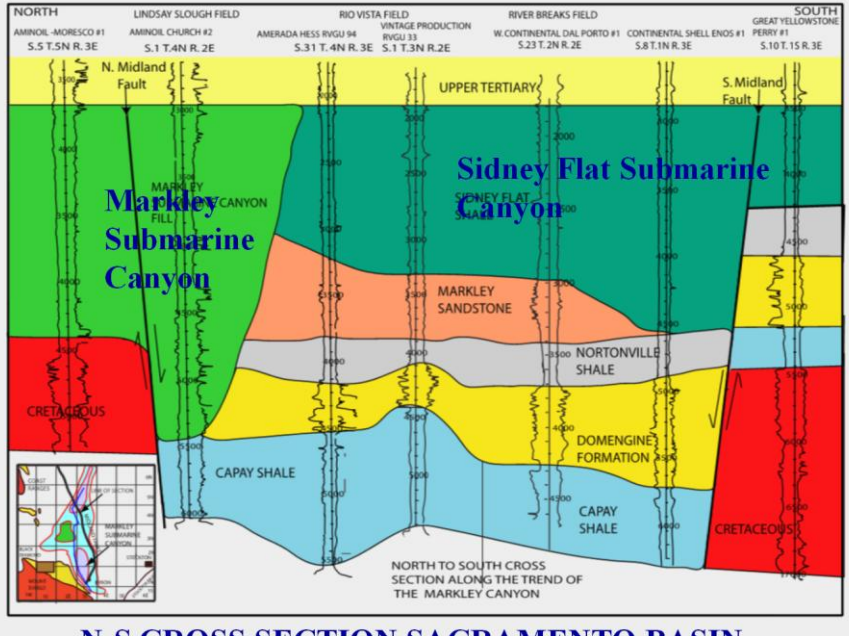
# STRATIGRAPHIC QUESTIONS

- What is the relationship between the Sidney Flat Shale and the Markley Mudstone fill in the subsurface (i.e. are they the same age)?
- What is controlling the distribution of the Sidney Flat Shale?

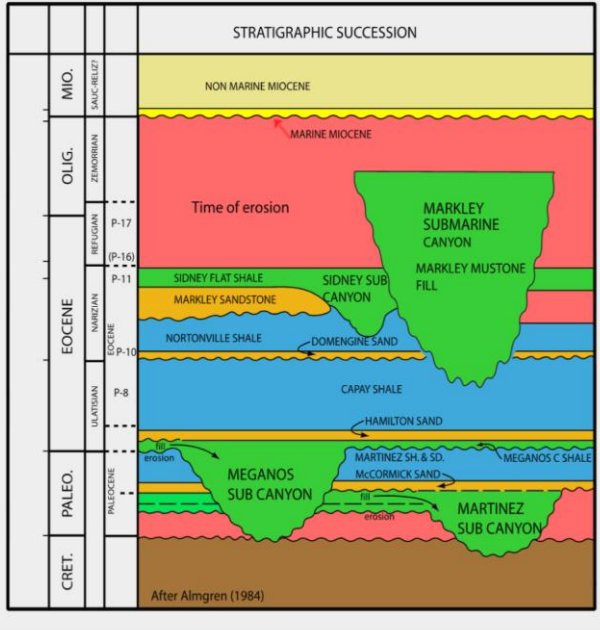
## AGE OF SIDNEY FLAT SHALE AND MARKLEY FILL

- Sidney Flat Shale and Markley Mudstone originally interpreted by some as the same age i.e M to U Eocene
- Almgren et al. found Markley Mudstone is Oligocene
- Sidney Flat Shale older, M. Eocene
- Sidney Flat Shale forams found in in the Markley Canyon fill, BUT contained w/in clasts and NOT inplace = transported clasts!
- Different age = Sidney Flat Shale is older

Mud rip-ups clasts sampled from subsurface core from Markley Mudstone




**N-S CROSS SECTION SACRAMENTO BASIN**




**LOWER TERTIARY SEQUENCES**

**DEPOSITIONAL CYCLICITY SHALE AND SANDSTONE SUCCESSION**

**What causes the cyclicity?**

# DEPOSITIONAL CYCLICITY

- **TECTONISM (subsidence and uplift)**

**Subsidence greatest in SW depocenter**

**CONTROLLED LOCATION**

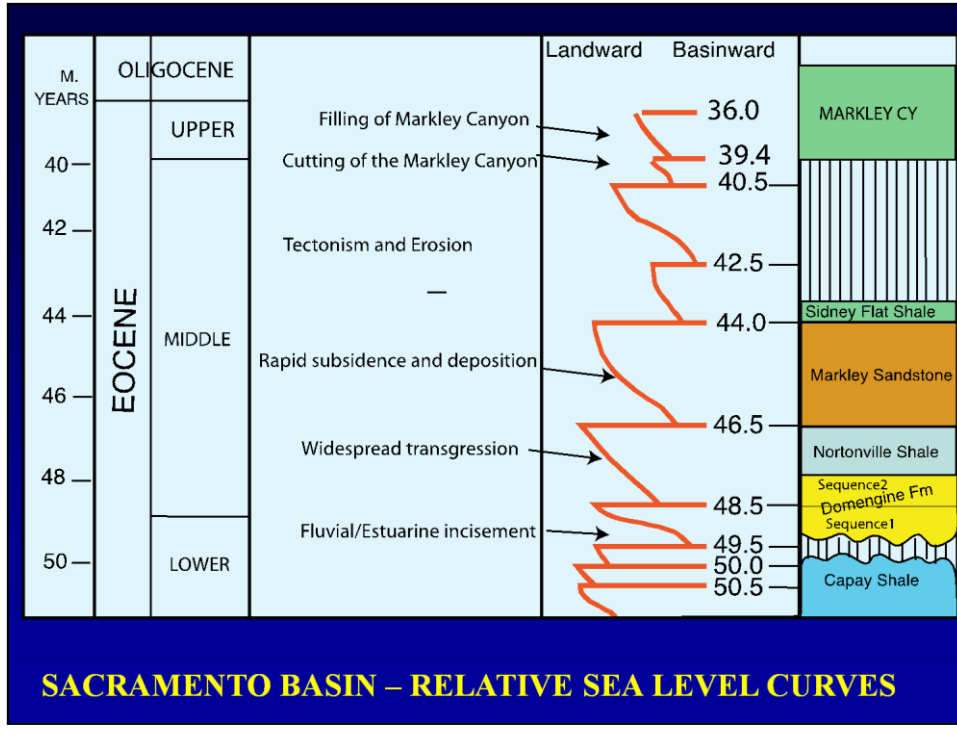
- **EUSTASY**

**Correlation with global sea level curves (Haq et al. 1988)**

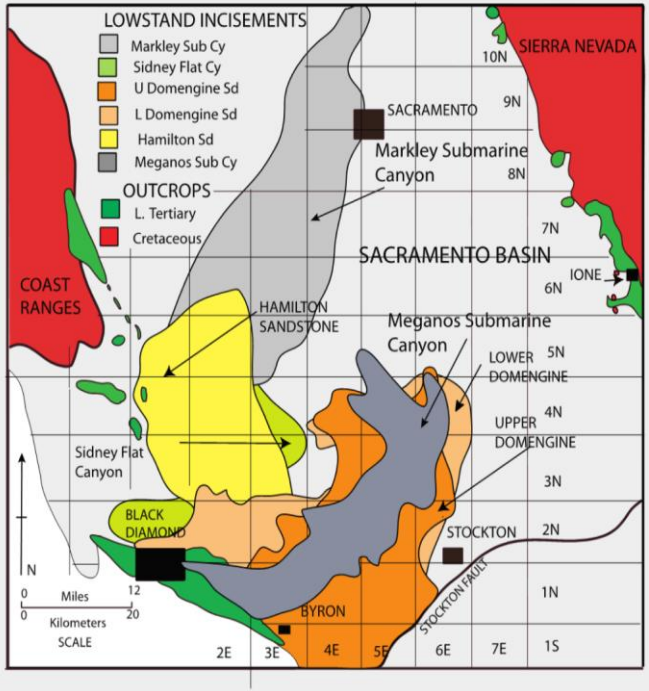
**CONTROLLED TIMING**

**TECTONISM AND EUSTASY COMBINE TO MAKE THE KIND OF SEQUENCE THAT FORMED**

Presenter's notes: Tectonism v Eustasy.
Tectonism - subsidence of basin due to sediment load and uplift along N-S faults. Eustasy is sea level changes involving climate etc.




**SACRAMENTO BASIN – RELATIVE SEA LEVEL CURVES**



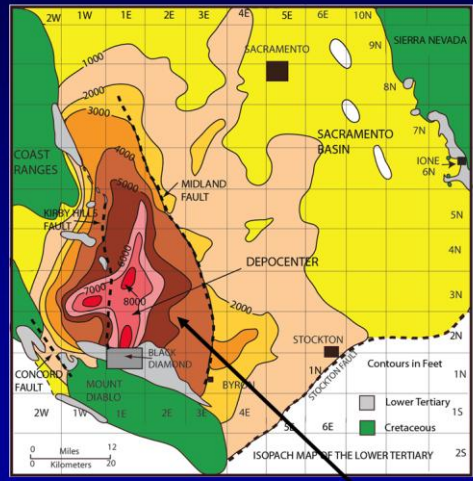

**Location of Sequences in the basin**

# CONCLUSIONS

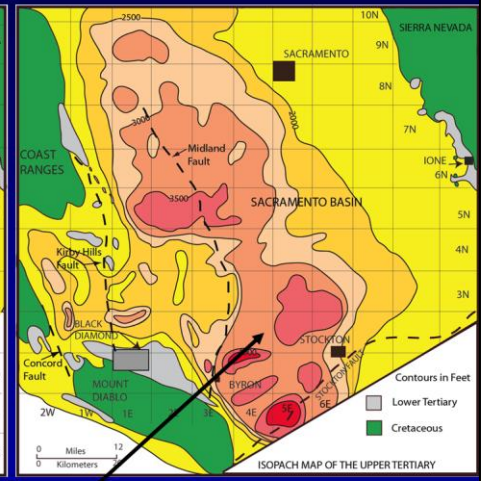
- Unpublished paleo data has revised the stratigraphy in the SE of the basin
- New, previously unrecognized middle Eocene submarine canyon in the south of the basin
- Interplay of tectonism and eustasy controlled where and when incised systems formed = reoccurring theme in this basin. Sub. Canyons formed during times of increased tectonism

# CONCLUSIONS

## LOWER TERTIARY




## UPPER TERTIARY




**DEPOCENTERS DIFFERENT LOCATION**

# QUOTE PROVIDED BY AL ALMGREN

"We have not succeeded in answering all our problems –indeed we sometimes feel we have not completely answered any of them"

"The answers we have found have only served to raise a whole set of new questions"

"In some ways we feel that we are confused as ever, but we think we are confused on a higher level and about more important things"