Lecture 5: Depositional Environment of the Monterey Formation

Now we know about basin genesis, why do certain rock types occur in different places and different times?

Explain the stratigraphic column of the Berkeley/Oakland Hills

Causes of changes in sediment supply

Using sediments to discern paleo-temperatures and global climate change

Google Earth Ocean View- sea floor evidence of last Ice Age effects

Start to use our geo-time machine  Add paleo-climates

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Present time
Geological Map -

a big deal for people today, but restrictive in interpretation of the past

Geological map of 12 Ma after un-faulting the area west of the Hayward Fault at a long-time average rate of 1 cm/year
Depositional Environment of the Monterey Formation

Objectives:

(1) Having acquired some idea of what may have caused the late Miocene sedimentary basins to form, provide some understanding of why certain types of sedimentary sequences filled them.

(2) Start your thinking about possible causes of the lithosequence in the Berkeley Hills …

Papers # 4 and 9 in Reader Paper is by Ken Pisciotto, Blake,

These basins record paleo-strands of strike slip faults and their evolution- define basin walls

The Miocene age Monterey formation records the deep basinal facies of a major late Tertiary cycle of basin development and filling associated with wrench-fault tectonism along the California coastal margin.
The basin were “silled” and with rapid subsidence biogenous diatomaceous sediment occurred in depocenters momentarily starved for terrigenous clastic sediment. The sequence ends with introduction of rapidly-deposited wedges of coarse terrigenous sediment which diluted the diatomaceous sediments.

Neogene facies show a progression from:
- Upper Miocene and Pliocene turbidites and neritic facies
- Miocene basinal shales and siliceous rocks
- Oligocene non-marine and neritic rocks

Besides tectonics playing a role in development of the Monterey formation, climatic and oceanographic factors also played a role.

These contributed to:
1. High plankton productivity in surface water
2. Deep water masses conducive to preservation of pelagic (deep) organic matter in the subtidal environment which was anaerobic (reducing)
3. A series of sediment-starved basins essential for collecting silica-rich sediments
The widespread siliceous rocks represent rapidly-deposited diatom ooze, recording high plankton productivity brought on by a general cooling of water temperatures and intense upwelling.

Butler and Dumont:

Key observations about diatoms:

Diatoms thrive where nutrient-rich bottom waters flow up slope to replace the surface waters moved basinward by atmospherically-induced circulation.

Organic-rich siliceous material settles through the water column beneath the upwelling region.

Oxidation of organic matter within the water column below areas of intense upwelling creates an oxygen-depleted layer and limits bioturbation at the sediment-water interface.

Interpretation of cooling trend:

Oligocene episode of refrigeration

Near the beginning of Middle Miocene 16.5-13 Ma, a transition from a glacial world to a glacial world occurred. Greatest change at about 14.8-14.0 Ma.
Monterey Hypothesis
Carbon deposition causing global cooling?

Uplift of the Himalayas?
This was the development of the East Antarctic ice cap

This transition is also reflected in the global sea level (eustatic) curve of Vaill.

Global sea level rise (+100 meters) from early early into middle Miocene, a maximum at 14-15 Ma, followed by a declining trend to a late Miocene minimum 100 meters below present sea level.

An upper non-marine markedly discordant unit

Clastic deposits of turbidites and marine sandstones representing the final stages of basin filling

Basinal shales and overlying siliceous strata corresponding to rapid subsidence of the basin

Oligocene to lower Miocene volcanic, continental and neritic marine clastic rocks representing the initial stages of basin formation

Bottom. This sequence is not complete everywhere. Why not?
Post-Glacial Sea Level Rise

Meltwater Pulse 1A

Last Glacial Maximum

Sea Level Change (m)

Thousands of Years Ago

Santa Catarina
Rio de Janeiro
Senegal
Malacca Straits
upper bound
Australia
Jamaica
Tahiti
Huon Peninsula
Barbados
lower bound
Sunda/Vietnam Shelf

Download Google Earth 5
Turn on Ocean View Layer
Noyo Canyon
Off shore drilling (SF Chronicle Dec 29, 2008)
If your Quiz score was below 70% you are expected to email Russell McArthur and go over the Quiz rmcarthur@berkeley.edu
Meet up at Hass Clubhouse
Bring safety vests and all gear