[PS]Capistrano Formation Source-to-Sink Analysis, Orange County, California*

Daniel E. Schwartz[1]

Search and Discovery Article #51489 (2018)**
Posted June 18, 2018

*Adapted from poster presentation given at 2018 Pacific Section AAPG Convention, Bakersfield, California, April 22-25, 2018

Winner of the Vic Church Award for the best poster at the 2018 Pacific Section Meeting, Bakersfield, CA.

[1]Daniel E. Schwartz, LLC; Black Fox resources, LLC, Bakersfield, CA (dschwartz004@gmail.com)

Abstract

A source-to-sink evaluation of the modern-San Juan Creek Watershed in Orange County, California was initiated to assess the origin and transport distance of distinctive breccia deposits exposed within the Mio-Pliocene Capistrano Formation (Tct) at Dana Point Harbor. Initial evaluation indicates that debris flows transporting tabular shaped cobble sized middle-late Miocene Monterey Formation (Tm) clasts were confined within channels in the submerged proto-San Juan Creek watershed. Cobble transport distance varies by channel location with respect to Monterey outcrops that were present in the Pliocene. There are three potential transport routes for the debris flows. Distance from source terrain to deposit varies from a minimum of 7.5 kilometers within proto-San Juan Creek, a minimum of 10.6 kilometers in the proto-Arroyo Trabuco Creek, and a minimum of 13.5 kilometers in proto-Oso Creek. Volumetric contributions of each tributary have not been determined. Breccia deposits in the Capistrano comprise over 20 percent of the channel fill. Rounded clasts of granule to cobble size derived from early Miocene to Triassic-Jurassic age strata within the proto-San Juan Creek watershed were deposited within pebbly sandstone and conglomerate beds in the Capistrano Formation (Tct) at Dana Point Harbor. These clasts and medium to course grained sands were transported via traction and grain flow processes within tributary channels for distances a minimum of 8.5 kilometers and a maximum of 45.7 kilometers.

The Capistrano Formation coarse-grained facies (Tct) that crop out at Dana Point Harbor, Orange County, California represent a multi-order channel fill succession deposited in an upper slope setting within the Capistrano Embayment. The distribution of the clastic facies is confined to the cliffs at the harbor and a few exposures in the city of Dana Point close to the Harbor. The Union Vaciadero Fee CH#1 well drilled in 1956 in San Juan Creek penetrated Capistrano Formation mudstone (Tcs) and over 300 meters of sandstone, pebbly sandstone, conglomerate, and breccia overlying Monterey Formation (Tm) siliceous shale. The upper portion of the well penetration corresponds to the Dana Point Harbor exposure. The coarse grained facies volumetrically represents less than 5% of the Capistrano Formation observed to crop out in the vicinity of the cities of Dana Point, San Juan Capistrano, and Mission Viejo. Its distribution is constrained within fault bounded basins formed by the San Cristianitos, Vaciadero, and Dana Point Faults. More widely distributed Capistrano Formation mudstone/siltstone facies (Tcs) represents slope deposition within the Capistrano Embayment. This facies is argillaceous and siliceous, finely laminated, and contains diatomaceous debris still in Opal-A phase. The Capistrano Formation is late Miocene to early Pliocene age as determined from foraminifera

extracted from the mudstone. The relationship of the channel facies to the mudstone facies is complex. Juxtapositions include: coarse clastic facies in lateral contact with mudstones at channel margins; coarse clastic facies overlying mudstones at erosive channel bases; and mudstone overlying channel complex facies in channel abandonment stacking patterns. Clastic-rich Capistrano (Tct) contains lithic fragments from a variety of source formations, including: hard laminated siliceous mudstone; sandstone; basalt; granite; and metamorphic detritus from the Peninsular Ranges to the east. Mudstone facies at Dana Point Harbor also contains sand filled dikes and sills intruded from underlying and adjacent Capistrano clastic facies.

Tabular clasts of opal-CT and quartz phase siliceous mudstone from the Monterey Formation are almost exclusively found in breccia deposits within the Capistrano channel complex, most likely the result of debris flows. Rounded clasts from other formations are exclusively found in pebbly sandstones and conglomerate in the Capistrano channels and were transported within the channel feeder system via grain- and traction-flow processes.

The tributary system that fed the Capistrano Formation channel complex is most likely similar to the modern San Juan Creek Watershed (Oso Creek, Arroyo Trabuco Creek, and San Juan Creek) that reaches eastward into the Peninsular Ranges and fetches detritus shed from Miocene to Triassic-Jurassic Formations. With the exception of the Dana Point outcrops, the Capistrano Formation exposed in the main drainage of the San Juan Creek Watershed is exclusively mudstone and siltstone. There are no coarse clastic facies found in Capistrano Formation adjacent to underlying or fault bounded Monterey. This supports the concept that the current drainage system corresponds with Miocene and Pliocene drainage and that minimal shifting of the channel occurred after initial incision. Channel sands within the channel complex have shifted, but the complex appears to have been relatively stable.

The geology maps of San Bernardino, Santa Ana, and Oceanside Quadrangles were updated in 2006 and 2007. The drainage system of the San Juan Creek Watershed has been assessed regularly, most recently in 2013. The system drains into the Pacific Ocean via San Juan Creek at Doheny Beach near Dana Point Harbor. It drainage area is 456 square kilometers (176 square miles). Elevation ranges from 1,733 meters (5,700 feet) at Santiago Peak to sea level at the mouth of San Juan Creek. Stream gradients range from 19 percent in Holy Jim Canyon to less than 0.4 percent at Doheny Beach. Gradient changes within creek beds correspond to lithologic changes and fault occurrences.

The composite drainage is crossed by the numerous faults, some associated with the north-south trending San Christianitos Fault system and a more eastern, northwest-southeast trending Santiago - Trabuco fault system (here named for the first time). The San Christianitos system juxtaposes middle Miocene and early Pliocene strata on the west and Oligocene and Miocene strata on the east. The Santiago - Trabuco system juxtaposes early Tertiary (Paleocene and Eocene) strata against late Mesozoic (Late Cretaceous) strata. These faults appear to have influenced paleo-topography and probably enhanced erosion of the Miocene Monterey Formation and the Cretaceous Williams Formation as stream gradients increase adjacent to these formation’s out crops.

Monterey Formation is cut by modern drainage along Oso Creek on the west, Arroyo Trabuco Creek in the center, and San Juan Creek on the east. Much of the contact between Capistrano and Monterey Formation occurs at faults associated with the San Christianitos Fault system. It is likely that debris flows shed from a fault scarp on the western margin of the late Miocene early Pliocene Monterey outcrop belt were carried down channels to be deposited as debrites in Capistrano Formation channels. Monterey Formation derived debris flows would have traveled

7.5 up to 13.5 kilometers to reach their current location at Dana Point Harbor. These transport distances are consistent with other studies of submarine debris flows.

Selected References

Bouroullec, R., and D.R. Pyles, 2010, Sandstone Extrusions and Slope Channel Architecture and Evolution: Mio-Pliocene Monterey and Capistrano Formations, Dana Point Harbor, Orange County, California, U.S.A.: Journal of Sedimentary Research, v. 80/5, p. 376-392.

Crouch, J., and J. Suppe, 1993, Late Cenozoic Tectonic Evolution of the Los Angeles Basin and Inner California Borderland: A Model for Core Complex-Like Crustal Extension: Geological Society of America Bulletin, v. 105, p. 1415-1434.

Kennedy, M.P., S.S. Tan, K.R. Bovard, R.M. Alvarez, M.J. Watson, and C.I. Gutierrez, 2007, Geologic Map of the Oceanside 30x60-Minute Quadrangle, California: California Geological Survey, Map Scale 1:100,000.

Morton, D.M., and F.K. Miller, 2006, Geologic Map of the San Bernardino and Santa Ana 30' x 60' Quadrangles, California: U.S. Geological Survey Open-File Report 2006-1217.

Vedder, J.G., R.F. Yerkes, and J.E. Schoellhamer, 1957, Geologic Map of the San Joaquin Hills-San Juan Capistrano Area, Orange County, California: USGS Oil and Gas Investigations Map OM-193.

White, W.R., 1956, Pliocene and Miocene Foraminifera from the Capistrano Formation, Orange County, California: Journal of Paleontology, v. 30, p. 237-270.

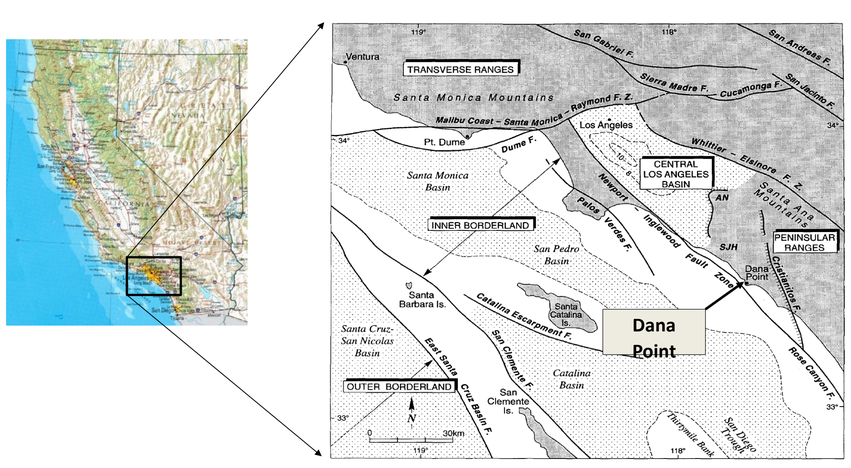
Yerkes, R.F., T.H. McCulloh, J.E. Schoellhamer, and J.G. Vedder, 1965, Geology of the Los Angeles Basin, California - An Introduction: United States Geological Survey Professional Paper 420-A, p. A1-A57.

Capistrano Formation Source-to-Sink Analysis, Orange County, California

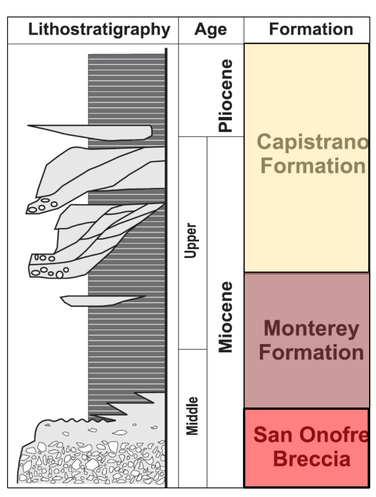
Daniel Schwartz, PhD. Daniel E. Schwartz, LLC; Black Fox Resources, LLC

- ***Questions:***
  - **What factors influence deposition of debris flows and grain or traction flows in a deep marine setting?**
  - **Were debrite provenance and transportation distances similar to those for pebbly sandstones and sandstones?**
  - **Can the Capistrano Formation in Orange County, California be a candidate to test depositional models for debris and grain flow transport in a deep marine setting?**

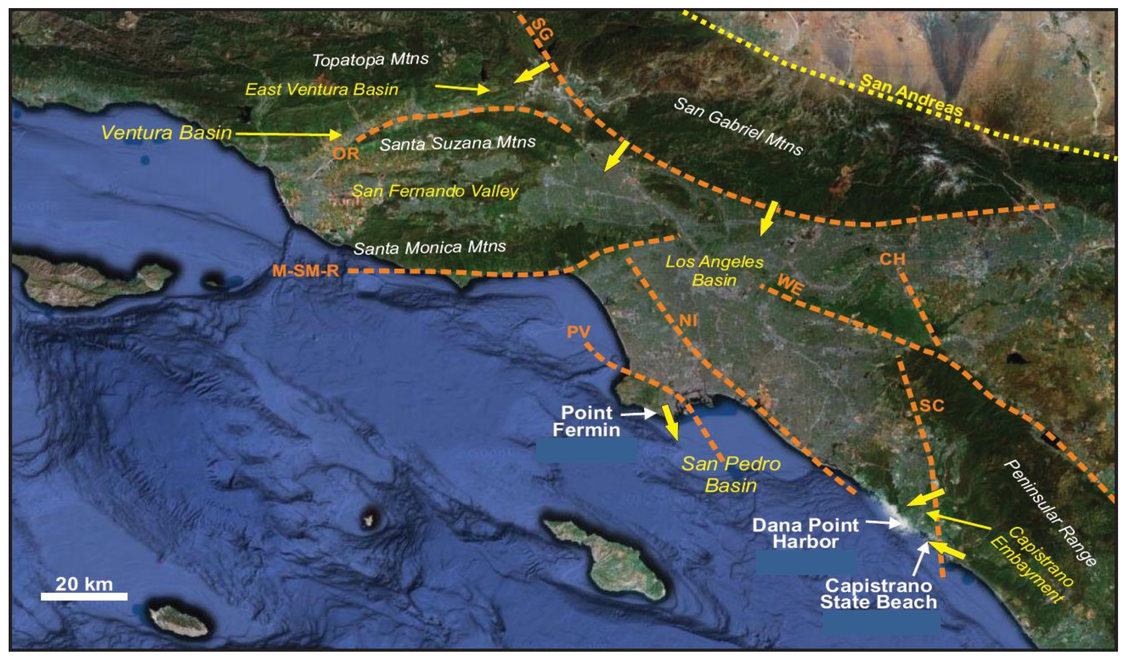
Location and Stratigraphy of the Capistrano Channels at Dana Point, Southern California



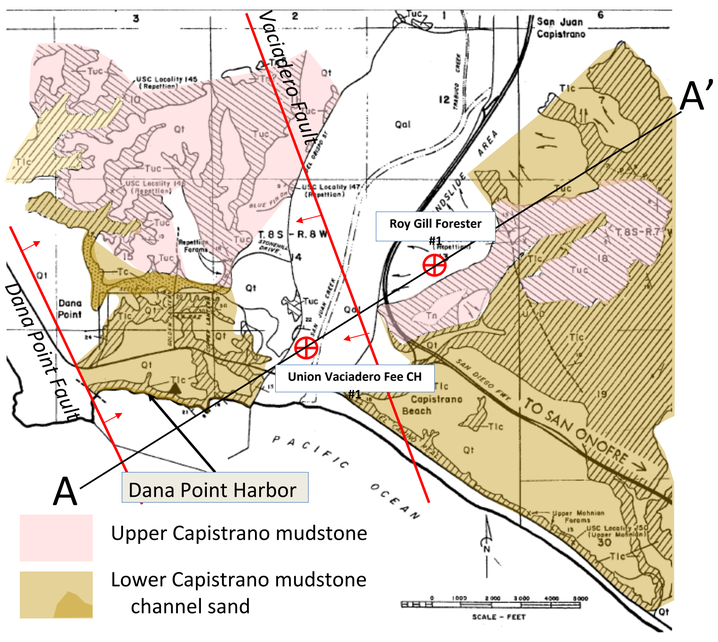
Major Faults and Provinces
(From Crouch and Suppe, 1993, modified from Yerkes and others, 1965)



Schematic Litho-stratigraphy.
(From Bouroullec & Pyles, 2010)

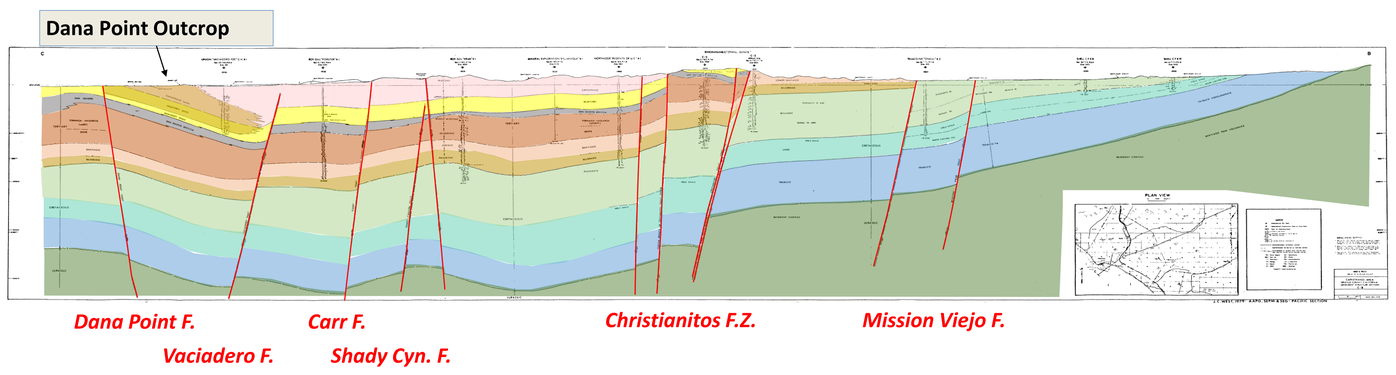


Geologic map of the Dana Point area and southwest to northeast structural cross section A-A'



Adopted from Vedder, Yerkes and Schoellhamer (1957) and White (1956).

Structural cross section offshore Doheny Beach east northeast ward to the Santa Ana Mountains, south of the San Juan Creek.

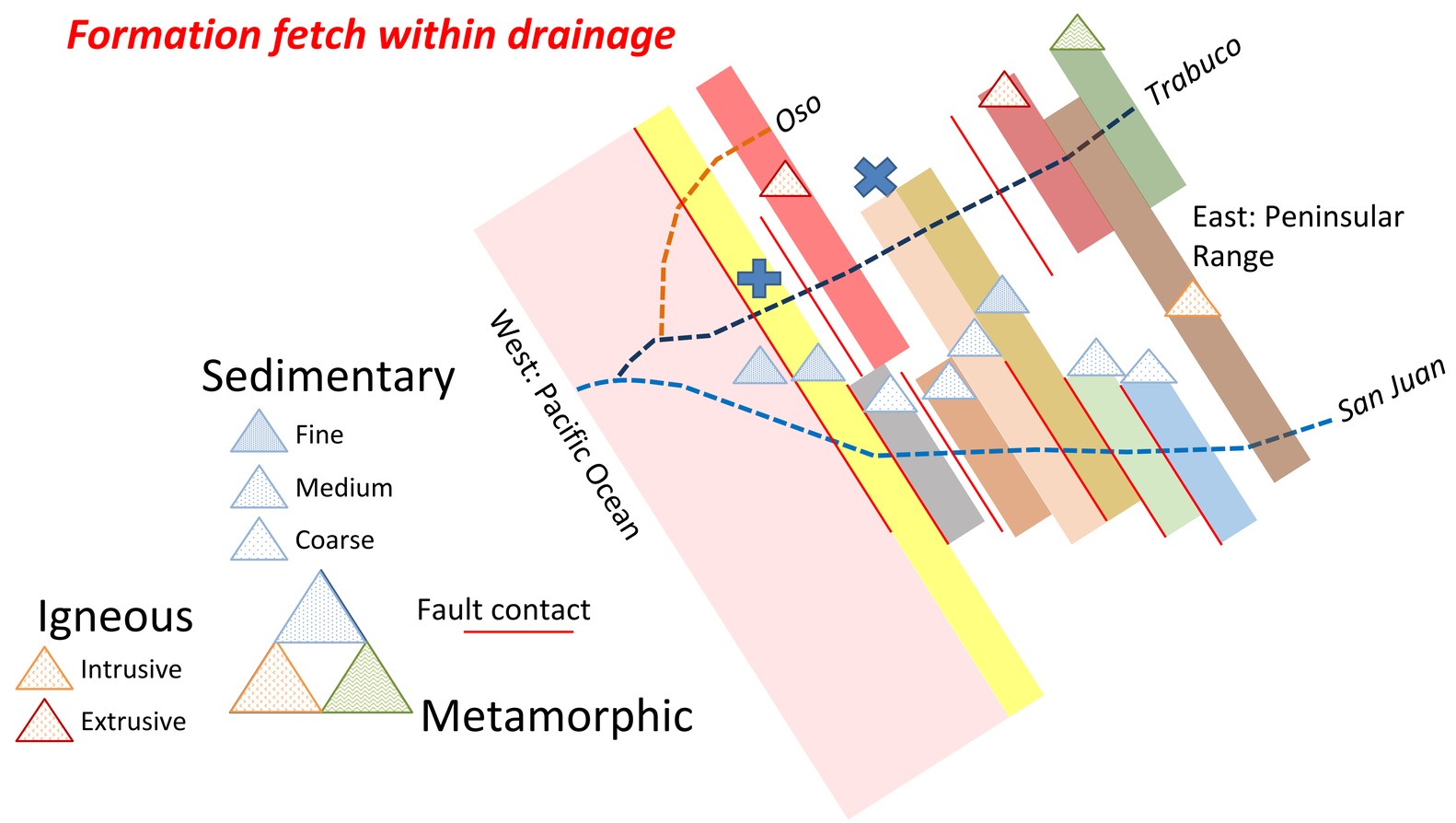


Stratigraphy

Tcs	Capistrano Fm silty mudstone sandstone facies	Tsi	Paleocene Silverado Fm coal-claystone
Tm	Monterey Fm siliceous mudstone	Kw	Cretaceous Williams Fm sandstone
Tsob	San Onofre Breccia	Kl	Cretaceous Lusardi Fm sandstone
Ts	Oligocene Temblor Fm sandstone	Ktr	Cretaceous Trabuco Fm conglomerate
Tsa	Eocene Santiago Fm silt/sand/congl	Jbc	Jurassic metasedimentary rocks

From: West, 1979: AAPG, SEPM, & SEG – Pacific Section Guidebook.

Formation fetch within drainage



Stratigraphy

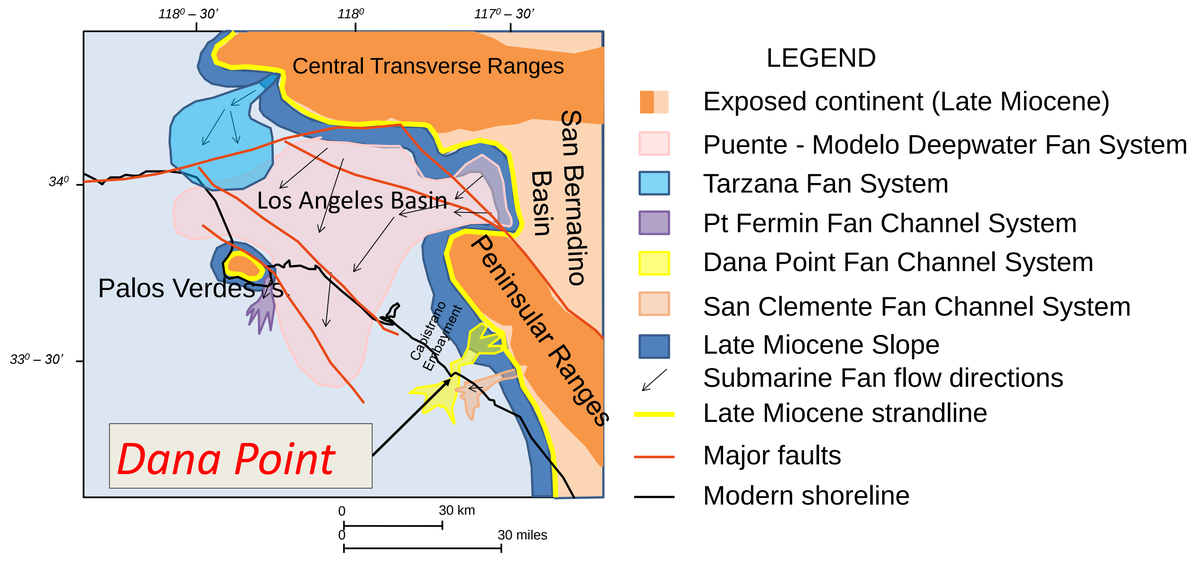
Tcs	Capistrano Fm Silty mudstone
Tm	Monterey Fm siliceous Mudstone
Tsob	San Onofre Breccia
Tv	Miocene Volcanics Basalt
Ts	Oligocene Sespe Fm Sandstone
Tsa	Eocene Santiago Fm Silt/Sand/Congl
Tsi	Paleocene Silverado Fm Coal-Claystn
Kw	Cretaceous Williams Fm Sandstone
Ktr	Cretaceous Trabuco Fm Conglomerate
Kvsp	Cretaceous Santiago Pk. Volcanics
Khg	Cretaceous Granitic Rocks
Jbc	Jurassic Metasedimentary Rocks

- ***Debrite transportation:***
- ***There are three potential transport routes for the debris flows.***
- ***Distance from source terrain to deposit varies from a minimum of 7.5 kilometers within proto-San Juan Creek, a minimum of 10.6 kilometers in the proto-Arroyo Trabuco Creek, and a minimum of 13.5 kilometers in proto-Oso Creek.***
- ***Assessment of the volume of Monterey debris in the three creeks indicates that Trabuco Creek is the predominant transport pathway.***

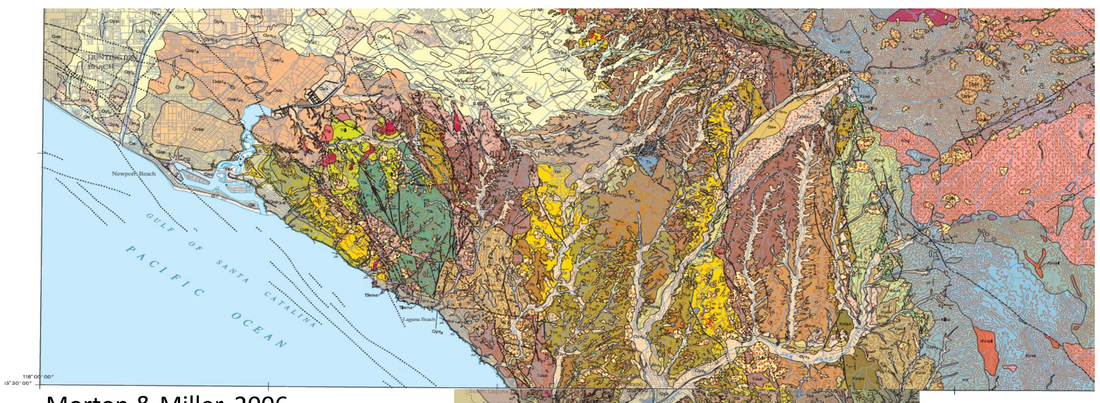
BLACK FOX RESOURCES, LLC

- ***Methods:***
- ***Compile maps created for geological assessment, depositional system, and watershed management***
- ***Utilize satellite imagery and aerial photographs to assess drainage patterns and underlying/exposed formations***
- ***Make ground observations and sample assessments to validate clast provenance and character***

Distribution of late Miocene to early Pliocene depositional systems in the Los Angeles Basin and Capistrano Embayment



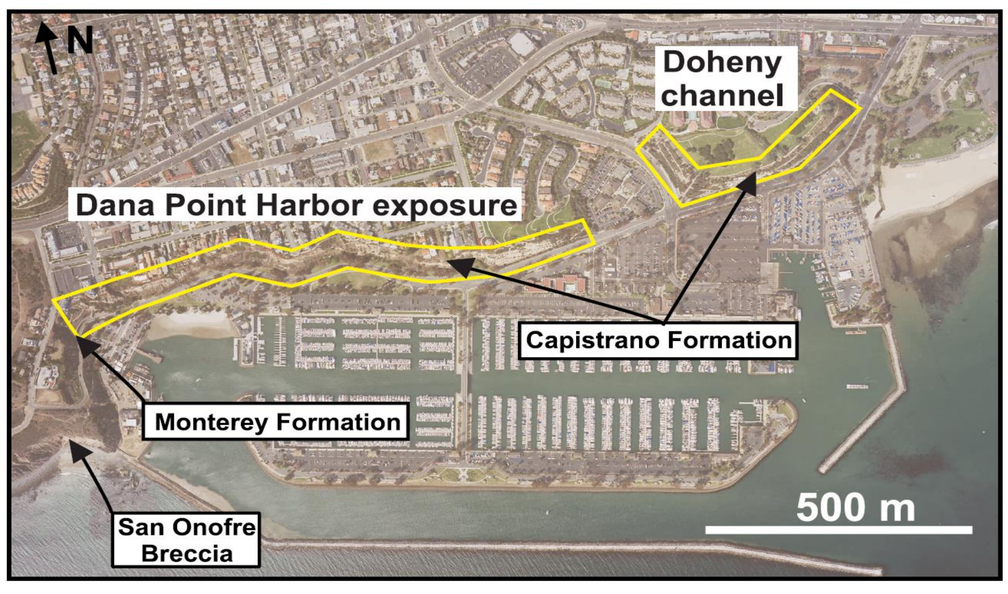
Recent geologic maps of the San Bernardino, Santa Ana, and Oceanside 30' x 60' Quadrangles, California



Morton & Miller, 2006

Kennedy & Tan, 2007

Aerial photograph of the Dana Point Harbor



Photograph from Dana Point Harbor Bureau of Management. The San Onofre, Monterey, and Capistrano Formations crop out at a wave cut terrace.

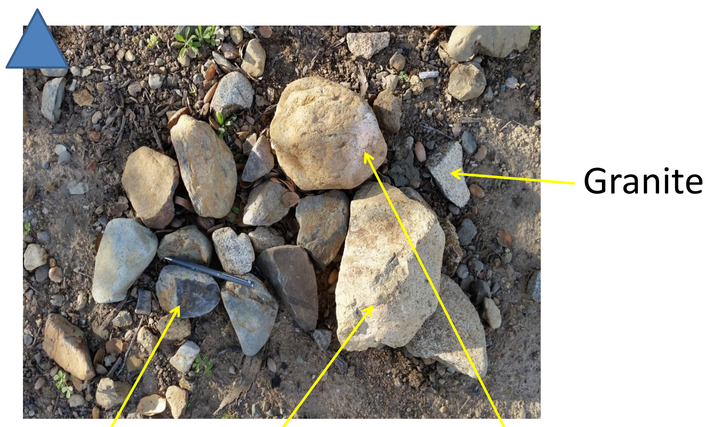
Photopanel of western part of the Dana Point Harbor exposure

- *Monterey and Capistrano Formations are separated by a fault (Dana Point Fault) to the west.*
- *The Capistrano Formation crops out on the main cliff and is composed of slope channels.*

Arroyo Trabuco Creek near intersection of Oso Parkway and Antonio Parkway: Monterey cut

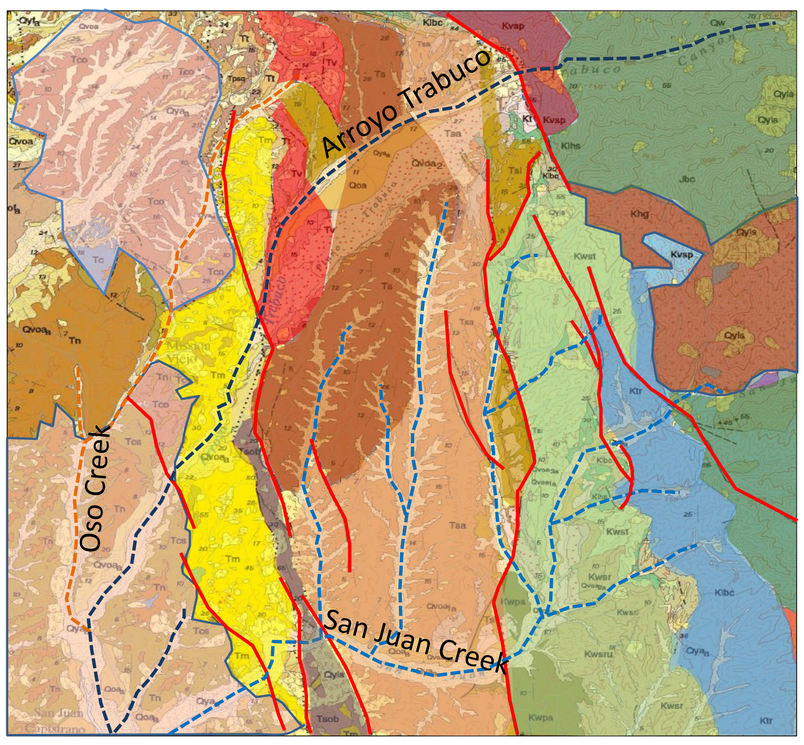
Arroyo Trabuco Creek view south-southwest from south of Oso Parkway.

Arroyo Trabuco Creek at intersection of Alicia Parkway and Santa Margarita Parkway: Silverado Fm & Santiago Peak Fm Cut



- ***Observations:***
- ***Monterey Formation outcrops within Trabuco Creek drainage have both east and west flank exposure***
- ***Monterey clasts within Trabuco Creek drainage adjacent to Monterey outcrops are oversized in comparison to older clasts, which are generally more angular than exposed at Dana Point Harbor Capistrano Formation outcrops***

Geology within the San Juan Creek watershed



Drainage

Oso Creek	Oso
Arroyo Trabuco	Trab
San Juan Creek	SJC

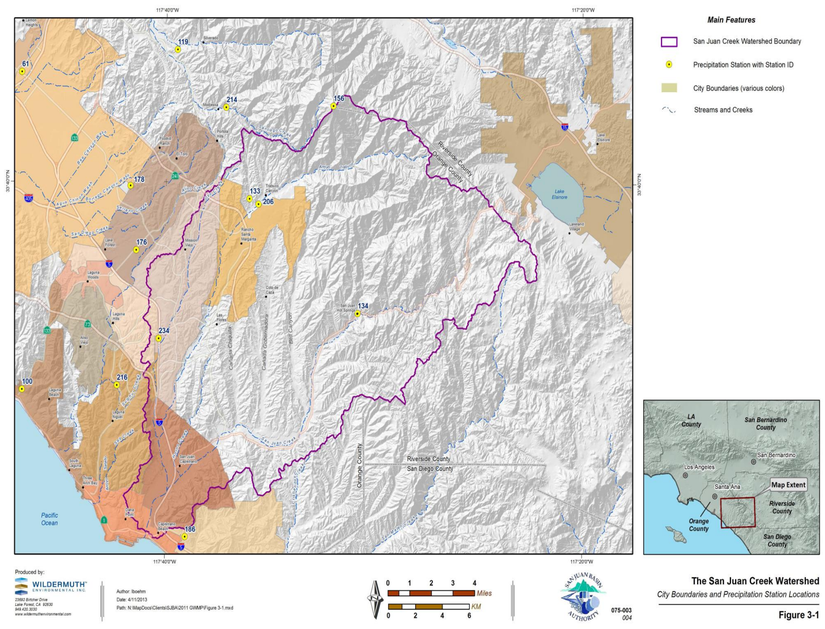
Stratigraphy

Tcs	Capistrano Fm Silty mudstone
Tm	Monterey Fm siliceous Mudstone
Tsob	San Onofre Breccia
Tv	Miocene Volcanics Basalt
Ts	Oligocene Sespe Fm Sandstone
Tsa	Eocene Santiago Fm Silt/Sand/Congl
Tsi	Paleocene Silverado Fm Coal-Claystn
Kw	Cretaceous Williams Fm Sandstone
Ktr	Cretaceous Trabuco Fm Conglomerate
Kvsp	Cretaceous Santiago Pk. Volcanics
Khg	Cretaceous Granitic Rocks
Jbc	Jurassic Metasedimentary Rocks

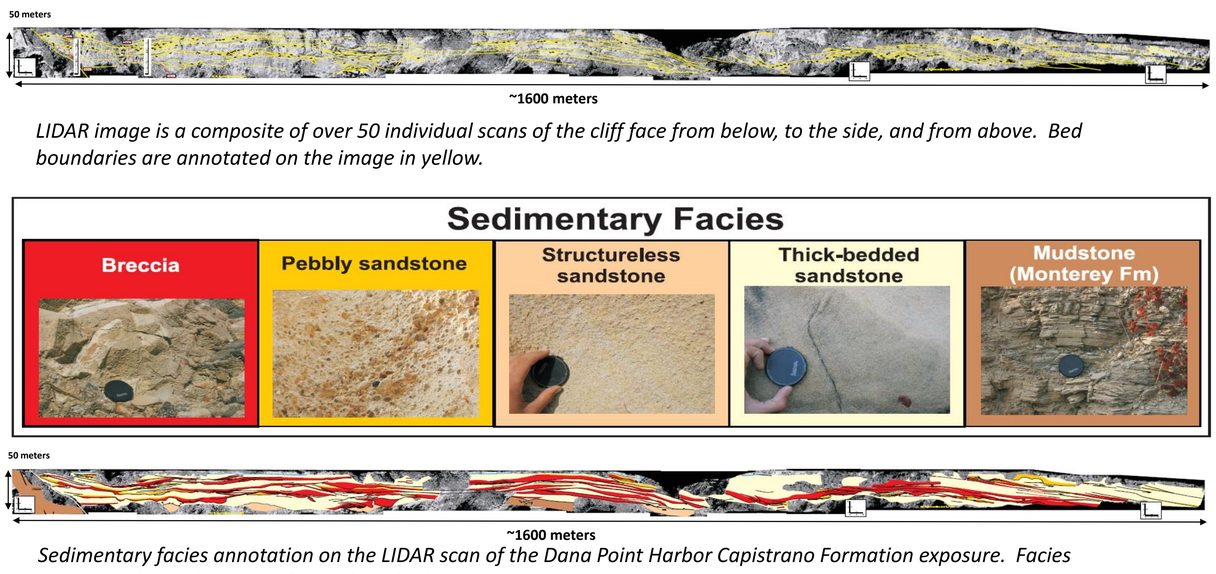
Structure

Faults

The San Juan Creek Watershed, Southern California



LIDAR scan and interpretation for the Dana Point Harbor Capistrano Formation exposure

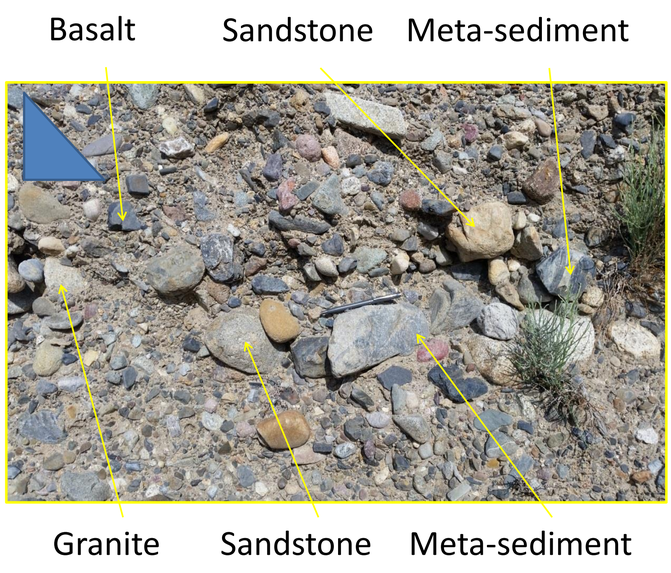


LIDAR image is a composite of over 50 individual scans of the cliff face from below, to the side, and from above. Bed boundaries are annotated on the image in yellow.

Sedimentary facies annotation on the LIDAR scan of the Dana Point Harbor Capistrano Formation exposure. Facies correspond to sedimentary facies described previously.

Breccia and conglomerate at Dana Point

Arroyo Trabuco Creek at intersection of Oso Parkway and Antonio Parkway: Monterey Cut



- ***Conclusions: Questions and Answers:***
  - **What factors influence deposition of debris flows and grain or traction flows in a deep marine setting?**
    - **Tributary channel gradient, structural confinement, and fault bounded formation contacts**
  - **Were debrite provenance and transportation distances similar to those for pebbly sandstones and sandstones?**
    - **Grain and traction flows travelled significantly farther and were probably less episodic than debris flows**
  - **Can the Capistrano Formation in Orange County, California be a candidate to test depositional models for debris and grain flow transport in a deep marine setting?**
    - **The Capistrano in Orange County is typical of ancient and modern active margin systems. Debrites were sourced from channel margins in structurally confined and cross cutting geometries.**