College: Science and Mathematics
Department: Geological Sciences
Program: B.S.
Assessment liaison: Matthew d'Alessio

1. **Please check off whichever is applicable:**
   - **A. ________ Measured student work.**
   - **B. ___X___ Analyzed results of measurement.**
   - **C. ________ Applied results of analysis to program review/curriculum/review/revision.**

Executive Summary

The department of Geological Sciences compared visual communications products from our gateway course to our capstone. We collected submissions by teams over three years in the gateway (n=13) and two years in the capstone (n=7). In the gateway course, the majority of student posters appeared haphazard and cluttered. Only one poster was organized around a scientific question or 'story' with a main message, while the rest largely included 'information dumps' without a coherent connecting thread. More than a third included entirely too much text to be appropriate for this genre. Very few used any elements of effective visual communication that we teach in courses after the gateway course. By the capstone course, poster design improved substantially. Students converged on an appropriate amount of text in most of the capstone posters. Students made some progress with organizing their posters around 'storylines' or scientific messages, but even when students identified a main message for their poster, they did not emphasize that message effectively, nor did they effectively relate each of the panels on the poster to their main message using targeted figure captions. Some of these items were discussed as part of the oral narration of the poster, but none of the posters stood alone as effective communicators of a coherent message or story. Our department decided that we needed to reinforce visual communication strategies. We identified a gap where certain courses in Tier 3 (~Junior year) did not have poster projects and so students may need more reinforcement. We also identified a need for our faculty to be on the same page about visual communication and developed a strategy for doing so without excessive time commitment by our faculty.

Context

In 2016, the Department of Geological Sciences modified its B.S. program with a suite of new and redesigned courses organized into 4 'Tiers'. The first tier is GE-level offerings that bring people into our major. Tier 2 courses are the first courses that students take after they have declared a major in our department and taught in a 'cohort' with the same students taking all five Tier 2 courses together (our major is small enough that we only offer a single section of each course). We identified one course as the 'gateway' course as it is usually the first course students take, GEOL 306. Within Tier 2, there is also a course called "Communicating

Geoscience" which was created to help cultivate student communication skills (written, oral, and importantly for geology, visual). Tier 3 courses include three required courses that build directly on Tier 2 (more advanced versions of the same subdiscipline), as well as four additional elective courses. Tier 4 includes two capstone courses, one field-based and one classroom based (GEOL 490).

Since our curriculum revision, we have offered the GEOL 490 course twice. Starting 2019-20, we decided to resequence our Tier 2 courses so that they flowed better into Tier 3. One ramification of this change is that GEOL 306 will no longer be our first gateway. This is therefore the perfect time to assess the data we have collected in the past three years within that course.

In 2018-19, we assessed a single SLO related to visual communication.

SLO

Students will be able to present polished summaries, both written and oral, of their geological discoveries.

Data

We attached a representative sample of posters to this report. We analyzed the reports using the attached rubrics, which we provided to students in GEOL 303 but was not explicitly given to the students in either the gateway or the capstone course.

Gateway Signature Assessment

We collected culminating posters from 4 years of our gateway course, GEOL 306. In this signature assessment, students prepare a summary of a rock that they collected on their field trip and analyzed in class. The assignment requires them to apply their overall understanding of rocks and the minerals that form them, and then to present their ideas in a common visual communication format for geology: a scientific poster. We are a small department, so we have a total of 9 team posters in our assessment archive.

Capstone Course Assessment

Our capstone course is newer and we only have two years of student work to evaluate. The capstone is a semester-long investigation of a topical issue with societal impact. In 2017, students evaluated the Aliso Canyon gas storage blowout and made recommendations about its future. In 2018, students studied the devastating landslides in Santa Barbara county that followed the Thomas fire and made judgements about what caused the landslides.

In 2017, the entire class created a single report and each pair of students was in charge of a single section of the report and presented that section. This format reflects what an actual team of geologic consultants might do to present a report to their client. There were a total of X sections in the report/presentation.

In 2018, we changed format where the instructor assigned each team a different possible 'cause' of the landslides. Each team produced a scientific poster designed to convince the audience that their 'cause' was the driving factor that was most important in causing the landslides. This format reflects how geologists might present their findings at an academic conference. There were a total of 3 posters. Earlier in the semester, the class took a field trip and students prepared posters much like they did in GEOL 306. This created an opportunity to compare comparable assignments between gateway and capstone, albeit for a different group.

Limitations of team assessments

Students completed the assignments in teams of 2-4, so they probably reflect the highest level of understanding and performance on the team. If teams do poorly, it provides an honest assessment of weaknesses in our program. If teams do well, it indicates that we are serving at least some students well but does not provide us a picture of how many students are 'left behind' and might not be able to individually produce the same quality of work as their team's submission.

At this point, there are a number of areas in which none of the teams are meeting our expectations and we will use this information to improve our program. Once we feel like the team artifacts all meet our expectations, we can begin drilling into artifacts produced by individual students. (But we aren't there yet.)

Results

Summary of Gateway Posters

OVERALL. The best way to describe the posters in the gateway is 'haphazard' and 'cluttered'. A majority included appropriate amounts of information, but very few organized or presented it well. They didn't really convey a coherent story and didn't use effective principles of visual communication.

Main message. Only three posters out of 13 identified a relevant scientific question and used that as a main message to organize their poster. Four of 13 used a logical progression of scale from regional down to microscopic. But nearly half (6 of 13) of the gateway posters simply dumped information onto the canvas without much regard to how it flowed.

Visual Communication. Only three posters used even a single principle of effective visual communication (in this case, it was "zoom in boxes"). None of the posters annotated their figures – pictures were just pasted onto the canvas to stand alone. In some cases, they had figure captions that described key elements in the figures, but none of the posters used visual cues to highlight or communicate what the figure captions conveyed.

Design. There was a fair amount of variation in design quality, but only one really looked clean and professional. The majority (7 of 13) could probably be described as 'cluttered' or 'haphazard.' 4 of 9 used less professional fonts.

Length. The key elements of 'length' for a poster are the amount of text and font size. Five had entirely too much text for a poster, 2 had too little text, and 6 of 13 seemed like they included an appropriate amount of information and text (even if it wasn't laid out well). Most did a good job with image sizes. We can attribute this success to clear expectations and early feedback from the instructor. But even in the 6 posters with the appropriate amount of text, the font size is way too small in 5 of them.

Peer Review

During Fall 2016, students used our visual communication rubric to assess their peers' posters. Peers were quite generous, giving scores ranging from 3.5-3.9 out of 4. As part of our assessment effort, professors scored their work at scores of 1.75-2.5 out of 4. This difference indicates that at the gateway level, these students do not have a good grasp of the effective principles of effective visual communication. But students, as a class, were able to identify that some posters were better than others – the highest rated posters by students were also highest rated by faculty, and lowest rated by students were also lowest rated by faculty. So the 'room for growth' is a need for students to adjust their baseline of expectations rather than an inability to discern differences.

Summary of Capstone Field Trip Posters

OVERALL. The four posters were remarkably consistent in their quality. A majority included appropriate amounts of information, but very few organized it well. They didn't really convey a coherent story and didn't use effective principles of visual communication. The improvement from the gateway class was in the realm of design where they all used simple, clean, and orderly layouts.

Main message. The titles of the field trip posters are evidence of the lack of 'story' – two of the posters list the location name and 'debris flow' while the others simply list the location name. A better poster would be organized around a main message about what we would see at that site (i.e., "Damage to homes because of insufficient debris flow capacity at San Ysidro Creek"). One group showed 'prevention measures' as the last panel when it seems like these would logically come earlier.

Visual Communication. Very little is done in terms of effective visual communication strategies. Most posters show individual panels that just come one after another without any relationship between them. For example, one group showed a precipitation graph on top of a discharge graph, but they had different horizontal scales such that we could not assess the correlations. In one case, there is a map of the Thomas Fire burn area separate from the debris flow area.

These could be combined so we could identify relationships, or at least the outline of the zoomed-in map should be shown on the bigger map.

Design. All posters are very similar in design – simple and clean.

Length. One big change since the gateway course is that all the posters more effectively chose the appropriate amount of information to present. None of the posters have too much text, while one of four has too little information. Two of the four posters had text that was way too small while two had slightly too small, but none of them had appropriately large font sizes for the text.

Summary of Capstone Final Project Posters

OVERALL. The good news is that each of the posters is organized around a central persuasive goal. Unfortunately, the elements of the poster do not tie strongly enough back to the main message. The story comes only from a presenter's narration and not from any cues from the poster itself. Like the capstone field trip posters, students chose to include the appropriate quantity of information but still are not using effective visual communication strategies.

Main message. Because the purpose of these posters was to persuade the audience, the students did a much better job including a main message than they did on the field trip posters (whose stated purpose was to merely to inform). The range of graphs, maps, and diagrams students chose effectively support their argument.

Unfortunately, they rarely tie each panel back to their main message. For example, a plot of Fire's effect on vegetation shows a graph of root area v. shear strength, but fails to add the explanatory label "Roots hold soil together, but fire destroys roots" (albeit this may be factually inaccurate, I presume that's the reason they chose to include this figure. The point is that they need to communicate why each element is present on the poster and how it supports their main message).

Visual Communication. Very little is done in terms of effective visual communication strategies. One poster makes effective use of arrows to draw attention to key positions on maps or data points, but it presents the rainfall maps and discharge plots as two separate panels. We would want to see how these correlate with one another. One poster shows a textbook recipe for a debris flow, but it should circle or highlight the 'water' ingredient to emphasize visually that this poster focuses on that factor. Another has graphs where the legend is tiny and they missed an opportunity to label the lines on the graph so it was easy to tell which was which (burned v. non-burned, in particular).

Design. Like the field trip posters, all posters are very similar in design – simple and clean.

Length. Like the field trip posters, nobody has chosen too overload their poster with too much information. One group does not include sufficient information to tell their story

Discussion

Students improved from gateway to capstone by:

- Choosing an appropriate amount of information (i.e., not overloading posters)
- Laying out posters with a simple, clean design (i.e., not haphazard placement)
- For persuasive posters, choosing items to place on the poster that support their overall argument.

Students still need improvement at:

- Recognizing that even informational posters should have a main message and story that organizes the information.
- Relating each panel back to the main message so that it's clear from just looking at the poster why they chose to include a particular piece of information.
- Presenting information on posters so that viewers can see relationships between items (i.e., zoom-in boxes to place photos in spatial context of maps, arranging pairs of graphs so that they have the same axes to allow viewers to identify correlations, etc…)
- Using larger font sizes so blind old professors can read them.

Reflection

Some key questions:

- How much do we address the concept of a 'main message' and storyline throughout the program?
- How much are we reinforcing visual communications skills throughout the program?

During our October faculty meeting, we performed a gallery walk of posters in our assessment library. Faculty made comments on the overall quality of posters individually, comparisons between gateway and capstone posters, and comparisons between field trip and culminating posters in the capstone.

Initial faculty responses were positive about the improvement between gateway and capstone. ("The graphs all have axes labels!", excitedly exclaimed the primary gateway course instructor when she saw capstone posters because she recognized the improvement in her students).

Need for Feedback and Revision. Faculty discussed the challenges with offering student feedback if we really want improvement. Since many of the posters are summative assessments, there was concern that students would not have any motivation to review feedback on them. One faculty member says that her students never look at feedback she provides on their writing, and faculty discussed strategies for improving this situation (1) offer chance for extra credit by resubmitting revisions, but this was not recommended because students that need this the most rarely take advantage of the opportunity; 2) Include a first draft and second draft submission with points for explicitly addressing feedback; 3) Reducing the number of assignments and making one full week of assignment being an explicit session for revising so that there is both time and educational scaffolding given to the revision process). This topic will require additional attention if we want to get to the stage of action items.

Visual communication. Despite the fact that we teach visual communication in our "Communicating Geoscience" GEOL 303 course, most of our faculty do not know what is taught in the course. And even among our instructors, we have some disagreements about the optimal end product. There is some desire to discuss these issues, but it is not seen as a priority given the range of department needs and demands on faculty time. We might consider using our assessment time during the remainder of this academic year to address this need, but this is an ongoing discussion among the chair and the assessment liaison. In the meanwhile, we plan to produce a 'visual communication' cheat sheet that faculty can distribute to their students that aligns with GEOL 303's strategies every time they offer an assignment that includes a visual communication product like slides or posters. This will educate faculty as well as ensure a consistent message across the program.

Action items for 2019-20 Assessment

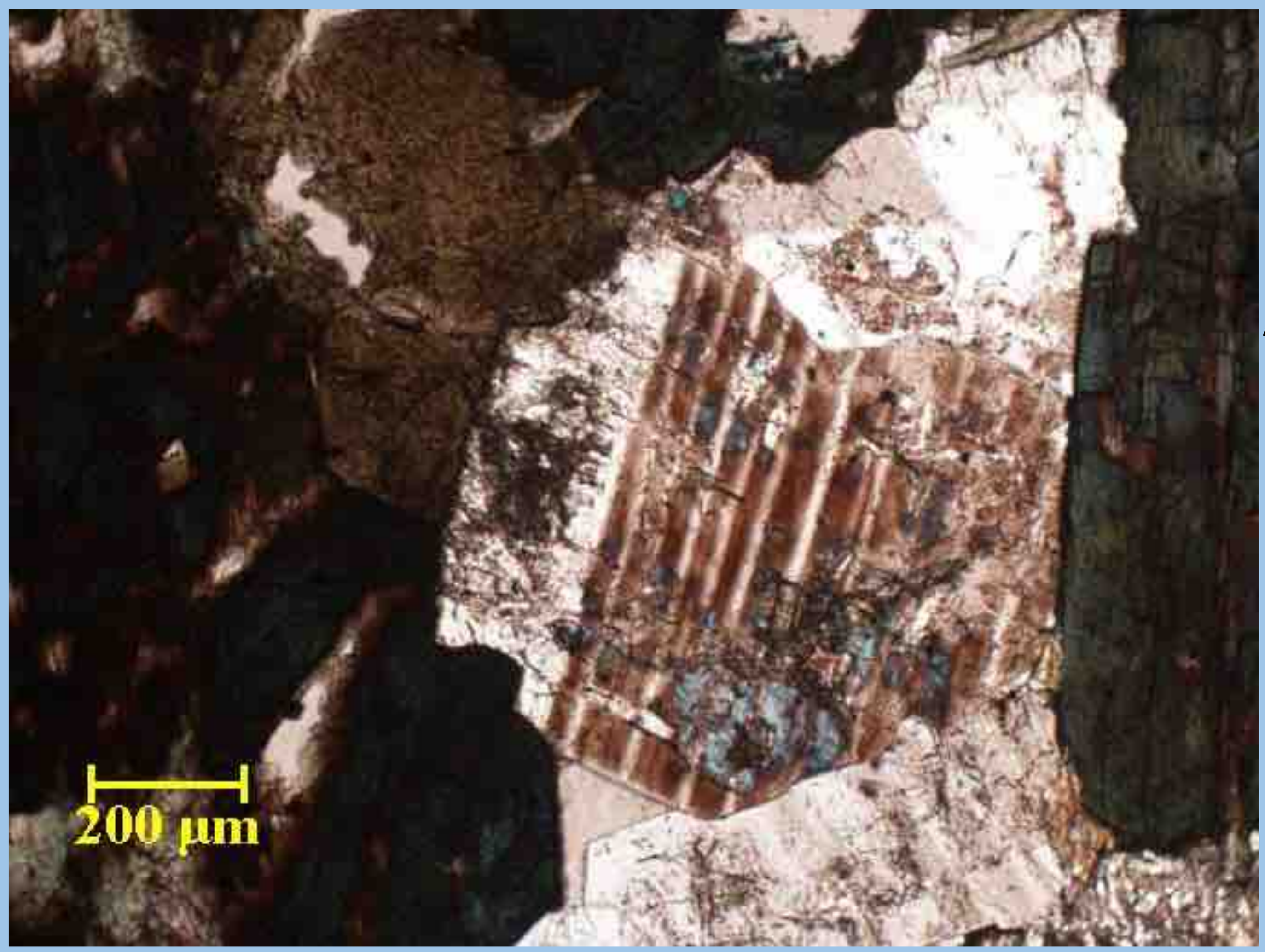
We would like to 'close the loop' on our assessment results from 2018-19. This includes:

- Provide examples of successful student work to future gateway and capstone classes so that they can see models of low, medium, and high performing work. With almost no instructional time, these examples can dramatically improve overall product quality.
- Include more posters and visual communication at the "Tier 3" level. Our Tier 2 (gateway) and Tier 4 (capstone) courses all have an emphasis on visual communication products, but there is a gap where we are not really doing much with them in Tier 3. The lead instructor for GEOL 307 immediately offered to incorporate such a project and is considering how to frame the activity.
- Create a 'visual communication strategies' handout for faculty to post and distribute with their assignments as a 'cheat sheet'.

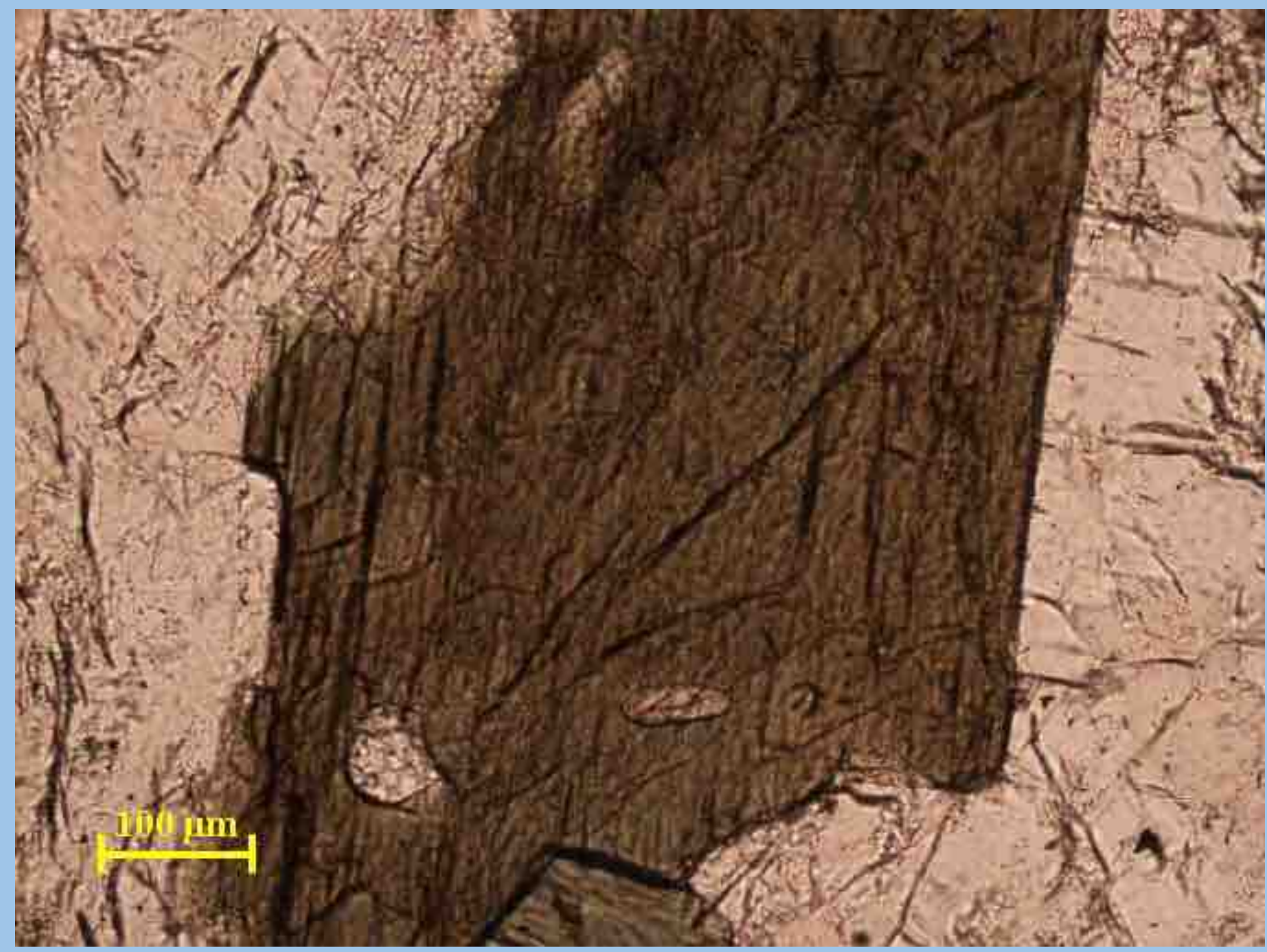
VISUAL COMMUNICATION (Visual)	The layout helps organize the ideas. Visual elements communicate information even without words, but the words are well targeted (such as well-chosen annotations). Colors are used effectively to highlight and emphasize.	Most sections meet the level 4 criteria, but each section has one area that could be significantly improved upon. Even if sections are “technically perfect,” they could have been laid out differently so that the layout provides visual support for the main idea (i.e., side-by-side comparisons are presented as two images side-by-side, cause and effect relationships are illustrated with arrows, etc…)	Most section meet the level 4 criteria, but as many as two or three sections might have two or more areas that need to be significantly improved.	Sections have a consistent pattern of problems. Few of the principles of effective figure design and poster design are evident.
DESIGN (Visual)	Overall, the work is visually pleasing and looks 'professional'. Good use of whitespace. Elements are arranged so that they don't look cluttered. Uses high contrast colors and minimizes the use of distracting background elements. Images are high	Overall, the work is acceptablly attractive, but may not quite as crisp and professional as level 4. Some sections may be better than others, but at least a portion of the work rises close to a level 4.	Overall, the layout doesn't look very thoughtful or intentional, but it's not terrible. It's possible that some sections might be a level 3, and some might be a level 1.	Overall, the work looks haphazard. Sections have a consistent pattern of problems. Few of the principles of effective figure design and poster design are evident.

	resolution. Uses professional typefaces.			
Length	The product fits in the space, but also looks nice (not crammed). All text is written in a font large enough that all words (including and especially figure labels) can be read by a blind old professor from 6 feet away. Images are enlarged to an appropriate size.	The product fits within the space but some sections are too crammed (or sparse). The font is large enough that most words can be read by a typical person from 6 feet away.	The product has entirely too much information, or entirely too little. Sections of the font are too small to read without stepping close to the poster.	The product appears incomplete.
PUBLIC SPEAKING (oral)	Overall, the presenter seems comfortable and professional. Speech is clear and loud enough to hear in the back of the room. Body language is open and relaxed. Speaker makes appropriate eye contact at appropriate times. Speaker stands in a place that does not obstruct the poster. Gestures are appropriate and support the message of the talk.	The presenter meets most of the level 4 criteria, but may have a consistent deficiency in one area, or may show signs of nervousness at the beginning that subside by the end of the presentation. These issues do not distract from the overall content of the presentation.	The presenter meets several of the level 4 criteria, but shows consistent patterns of deficiency on several of categories, or one or more aspects of the presenter’s delivery distract from the overall content of the presentation.	The presenter appears uncomfortable during the entire presentation. There is lots of stumbling over words and it is very hard to focus on the material being presented.

Indian Cove Hornblende Diorite



Peter Nahas, Zaira Martinez, Mony Sea, Andrew Barajas



<u>Andesine:</u>
Main mineral
Intermediate between albite and anorthite
Albite twinning
High temperature mineral

<u>Texture</u>

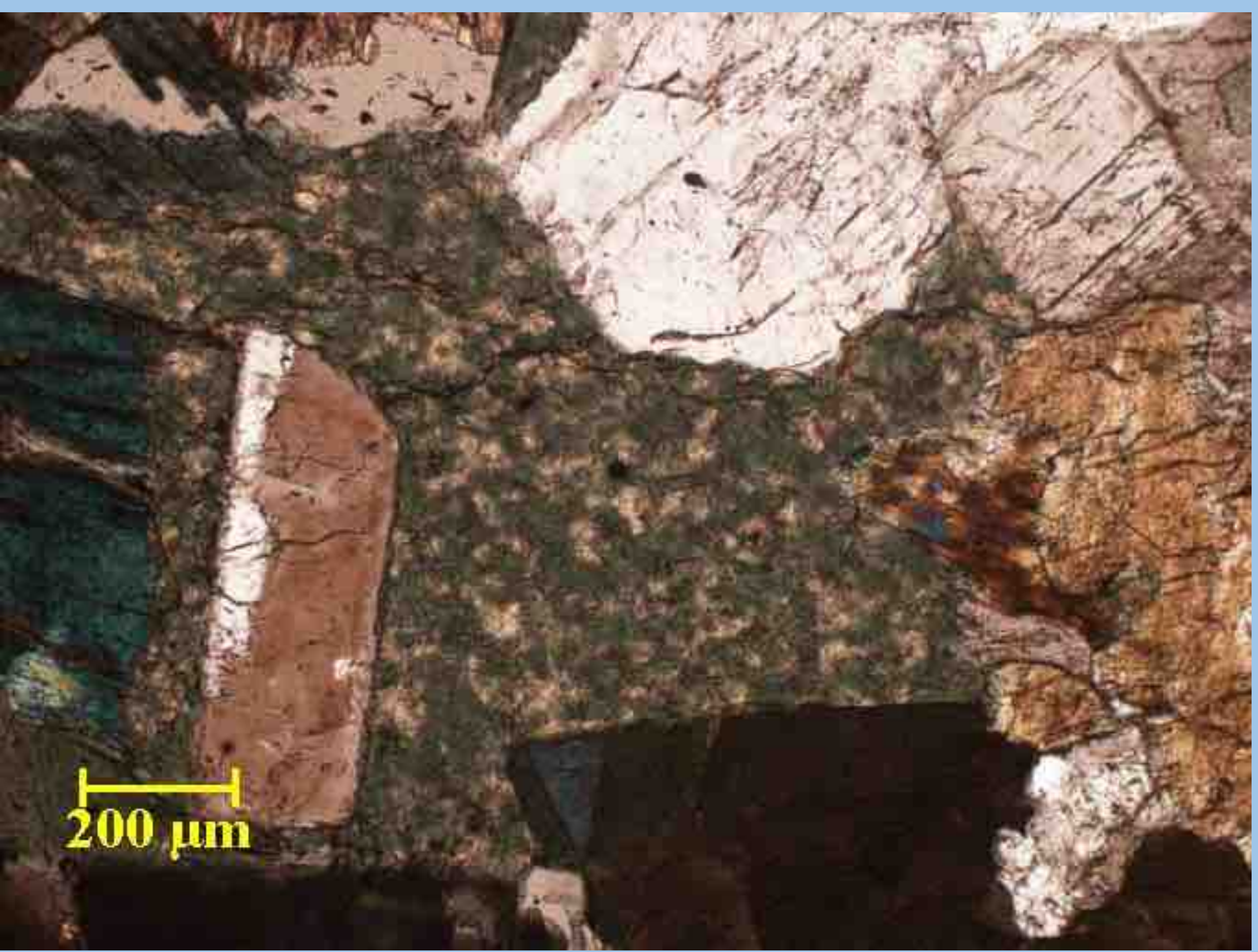
- Equigranular
- Medium grained
- No fabric

<u>Environment</u>

- 34.10574°N 116.14900°W
- Mesozoic subduction
- Partial melting
- Mafic dike forms
- Exposed due to erosion

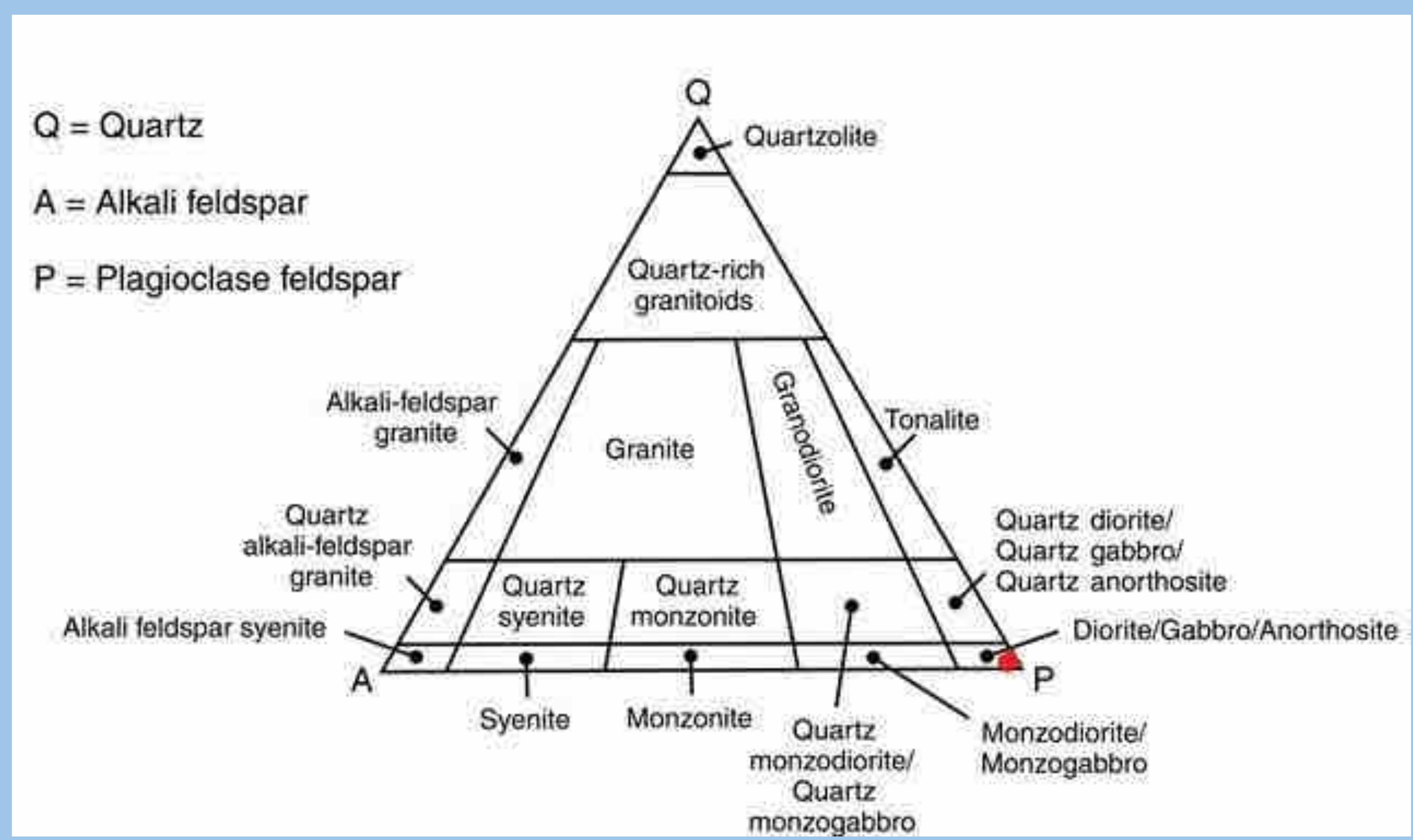
<u>Hornblende</u>

Main mineral
2 cleavage planes at 60° and 120°



<u>Quartz</u>

Accessory mineral
Undulose extinction
Low order interference colors



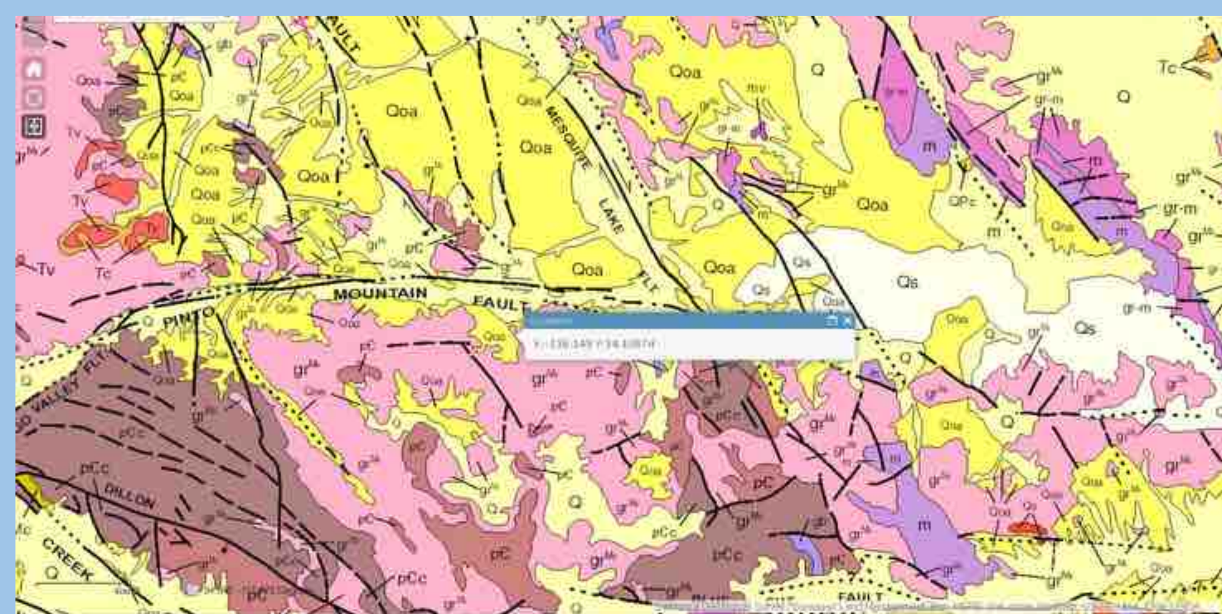
<u>Source Rock</u>:

45% Hornblende 50% Andesine 5% Quartz

<u>Ilmenite</u>

Opaque
Lath-like habit

The hand sample on the left shows acicular crystals of Hornblende randomly oriented in the Plagioclase



KELSO DUNES: Sand or Sanidine?

Tatiana Waller, Sean Hommer, Leticia Medina and Lena Vincent

The Kelso Dunes were created over the past 25,000 years and span more than 45 square miles. The highest dunes in the system tower as high as 600 ft. (160 meters) above ground. Huge amounts of sand were needed to create these magnificent features, but it has been discovered that no new sand is replenishing the dunes. The Kelso Dunes represent a small part of a much larger sand transport system that includes the Devil's Playground. Most of the sand came from the Mojave River sink, east of Afton Canyon. The sand was gradually blown by the winds from the northwest, transporting the sand southeast, and slowed down when it reached the Granite Mountains. The wind deposited the sand it was transporting, which accumulated at the base of the mountains to form the Kelso Dunes.

Sample Characterization

After collection, we analyzed our sand sample without magnification, with a hand lens (10x magnification), and in thin-section (10x ocular plus 4x objective zoom for 40x magnification). We describe the observations made with the naked-eye and a hand lens below.

To the naked-eye, the sand is light in color with a pale brown to pink hue. It is smooth to the touch and does not appear to feature any coarse grains, although individual grains are discernable. Very dark fragments are also noticeable. Upon exposing the sample to a magnet, these fragments are separated from the remaining grains, which demonstrates their magnetism (Figure 1).

Using a hand lens (Figure 2), many different mineral and lithic grains are distinguishable. The grain size ranges from fine sand (100 μm) to medium sand (400 μm), which are moderately to poorly sorted. The sand grains vary slightly in degree of roundness, the majority of grains being subangular with a relatively small fraction having a more rounded appearance.

Our observations correlate with those made from our grain-mounted thin section, which are discussed in the far right section.

Figure 1
The sand contains a significant fraction of relatively small, dark grains. When an everyday hand magnet is run over the surface of the sample, a large number of these darkly colored grains are found to be very strongly attracted to it, suggesting that they are pieces of detrital magnetite.

Figure 2
Sand sample at 10x magnification, as observed with a hand lens. Most grains are glassy in luster and light in color. Many have a pink to orange hue. Some very dark grey to black grains are also visible. The grains are moderately sorted for the most part, but some are significantly larger than others (see upper left quadrant). There also appears to be slight variations in roundness throughout the sample.

References

Bureau of Land Management (BLM): http://www.blm.gov/ca/st/en/fo/needles/wilderness/kelso_dunes.html

BLM Map: http://www.blm.gov/style/medialib/blm/ca/pdf/pa/wilderness/maps_7pt5.Par.34721.File.dat/kelsodunes10.pdf

DesertUSA: http://www.desertusa.com/mnp/mnp_kelso.html

US Geological Survey (USGS): http://geomaps.wr.usgs.gov/parks/mojave/kelso1.html

USGS Geologic Map: http://geomaps.wr.usgs.gov/parks/mojave/kelsomap.html

Methods

The sand sample was collected on site on the southeast side of the dunes (Figure 3) and brought back to the laboratory. A thin spread of the sand was then mounted in epoxy (Figure 4), allowed to set overnight, and sent for thin-sectioning. This yielded a 30 μm grain mount subsequently used in our analysis using a petrographic microscope.

Figure 3
Aerial map of Kelso Dunes relative to Granite Mountains off of Kelbaker Road. Red "X" denotes sample collection site.

Figure 4
The sand was poured onto double-sided tape and covered in epoxy. After setting, the sample was sent for thin-sectioning to obtain a 30 μm grain mount.

Geologic Setting

Based on our observations of the sample at different magnification levels, we discerned that the sand is composed of grains with variable ages, some being more mature than others. This is evidenced by roundness, poor sorting, and the apparent quartz/ feldspar to lithic fragment ratio. This is consistent with the fact that although the dunes are no longer actively growing, they formed in phases over a moderately long period of geologic time.

The sand is made up of minerals and tiny pieces of rock that were once part of a much larger rock. These rocks became sand due to the processes of mechanical and chemical weathering. Many of the principal and accessory minerals, along with the lithic fragments that were observed in our sample likely originated northwest of the Dunes, in the Soda Mountains (Figure 5), and eventually accumulated in Soda Lake.

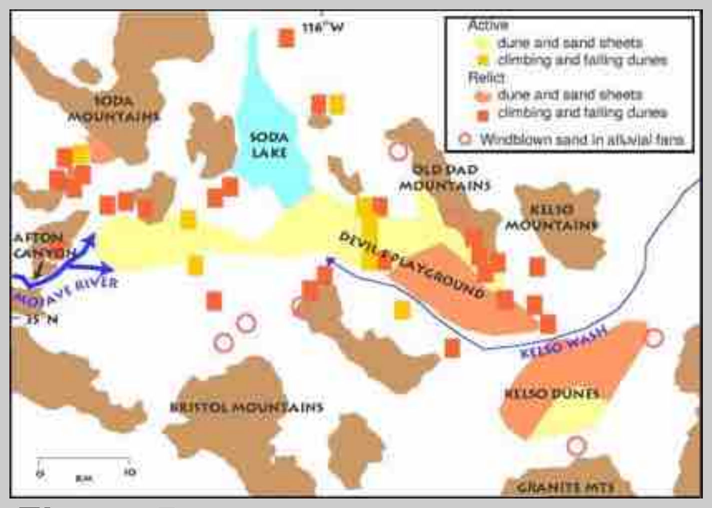


Figure 5
Geologic map of the Devil's Playground region highlighting the active and inactive regions of the Kelso Dunes.

When the lake dried up in response to a change in climate, the sediment became exposed and was eventually transported by the wind to form the Kelso Dunes. In addition, some of these sand grains were eroded from the San Bernardino Mountains and transported eastward by the Mojave River.

Origin of Hornblende

The hornblende minerals that can be found within our sample most likely originated in the surrounding mountainous areas that contain igneous rock formations. Based on the wind and water flows that transport the sediment to the Kelso Dunes area, we can hypothesize that the Soda, Old Dad, and Kelso Mountains all contributed heavily to the quantities of hornblende grains found throughout these dunes.

Mineral Identification

A number of minerals are readily identifiable using a 10x magnification hand-lens. At this magnification, it appears that the majority of the sample is composed of quartz grains (~50%), with feldspars also being heavily represented (~35). Micas, garnets, magnetite, and a few olivine grains are also visible in addition to lithic fragments (~15%)

In thin-section, the sample is also dominated by quartz, feldspars, and lithic fragments (Figure 6 ABC), with some accessory minerals, as listed above, present in the field of view (Figures 7 and 8). In addition, other minerals not obvious at the low magnification of the hand lens do appear in the grain mounted thin-section. These include the clinopyroxene augite (Figure 9) and several amphibole minerals, namely actinolite (Figure 10) and hornblende (Figure 11). Olivine and garnet, however, though visible at lower magnifications, did not appear in our grain mount.

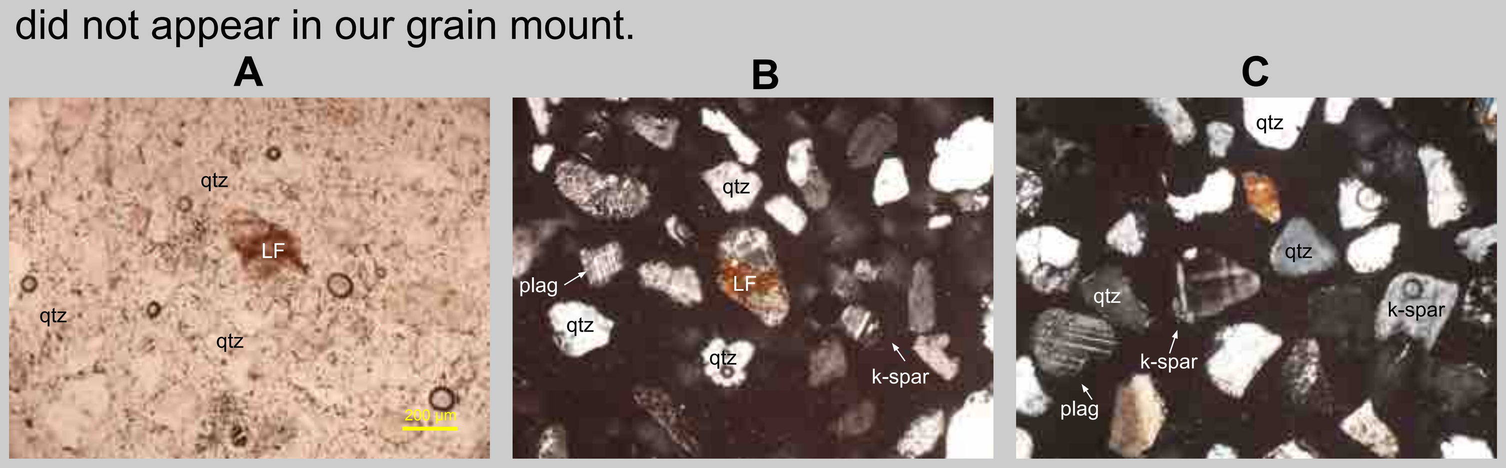


Figure 6 - Photomicrographs in plane-polarized light (PPL) and cross-polarized light (XPL) of the grain mount. Most of the grains are quartz and feldspars, which are difficult to distinguish from the epoxy in PPL due to low positive relief. Plagioclase is identifiable in XPL by albite twinning, and K-spars by tartan twinning (microcline) and a more cloudy appearance (orthoclase) in XPL. A carlsbad twin of orthoclase can been seen in panel B. A lithic fragment (LF) occupies the center of the image in panels A and B.

Figure 7
Biotite (bt): pleochroic in PPL (brown to green). High order interference colors in XPL. Single plane of cleavage, elongate "bacon" habit.

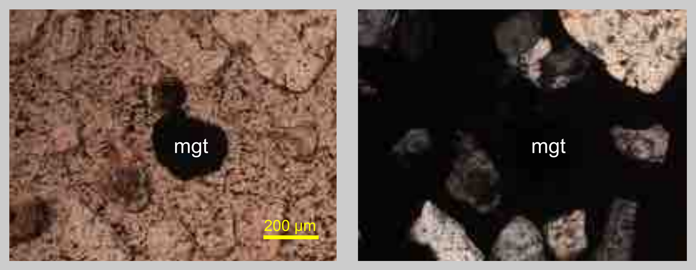


Figure 8
Magnetite (mgt): opaque mineral extinct in both PPL and XPL. Equant habit.

Figure 9
Clinopyroxene (CPX): pale green in PPL, non-pleochroic, high positive relief. 2nd order blue interference colors in XPL. Two planes of cleavage, each at about 90 degrees. Likely augite.

Figure 10
Actinolite (act): weakly pleochroic in PPL (pale green to pale blue). High order interference colors.

Hornblende

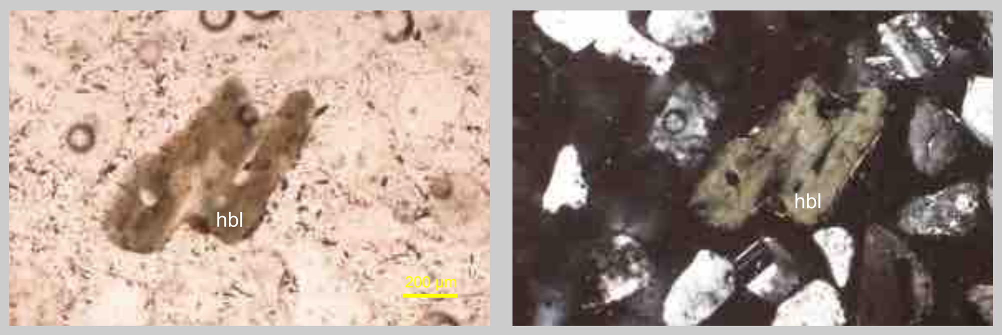


Figure 11
Photomicrographs in PPL (left) and XPL of a hornblende (hbl) crystal.

Strongly pleochroic with colors ranging from dark green to brown in PPL. Moderate to high positive relief. Two planes of cleavage not at right angles (~60° and 120°). Higher order interference colors (2nd order blue/green) and symmetric extinction angles in XPL.

Romero Creek Debris Flow
Montecito, California

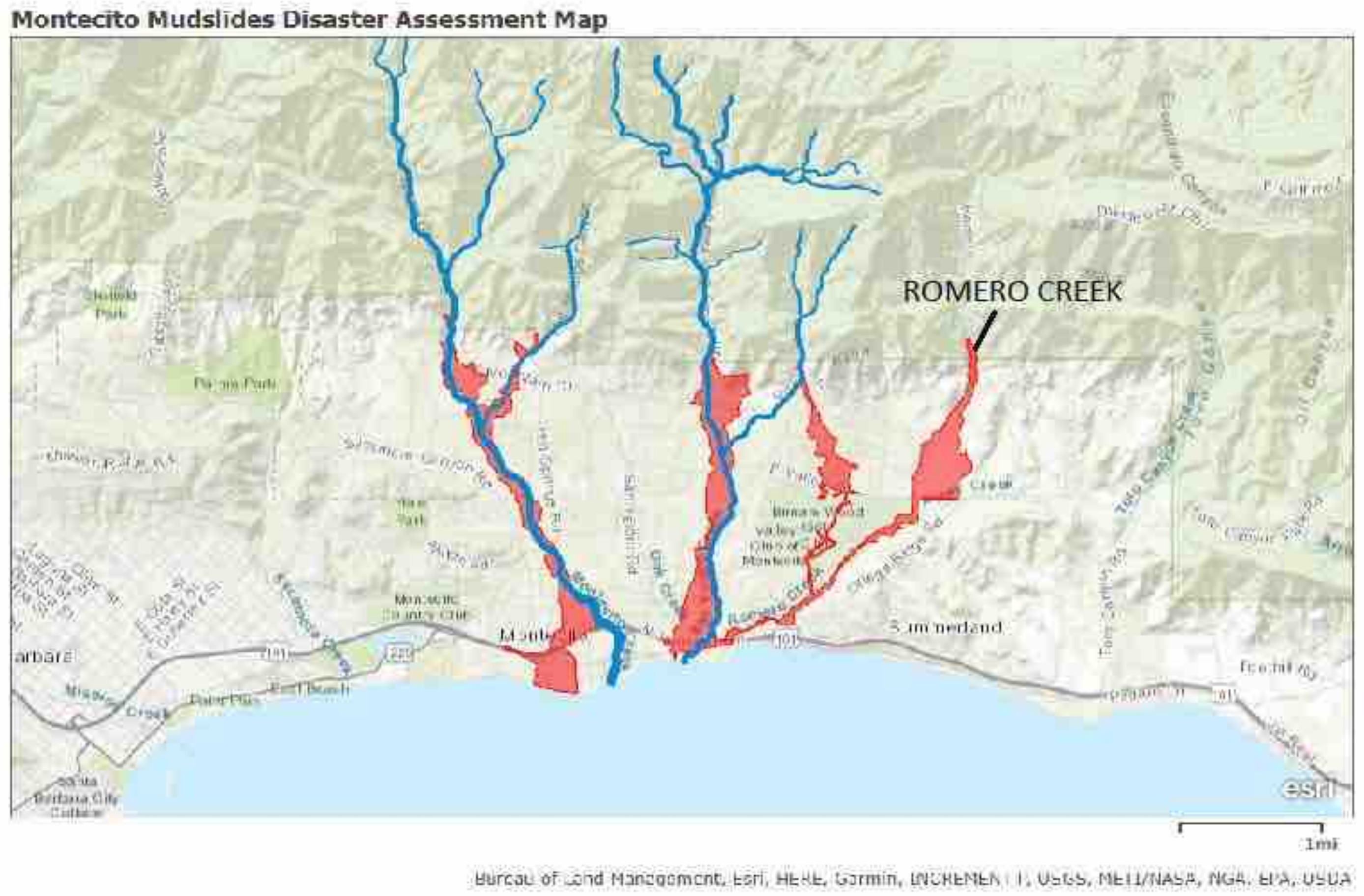
Andrew Barajas, Isabel Pina, Talen Wickenden, Miguel Zamora-Tamayo

490-trip

Location

- North of Summerland in Montecito, CA

Montecito Mudslides Disaster Assessment Map

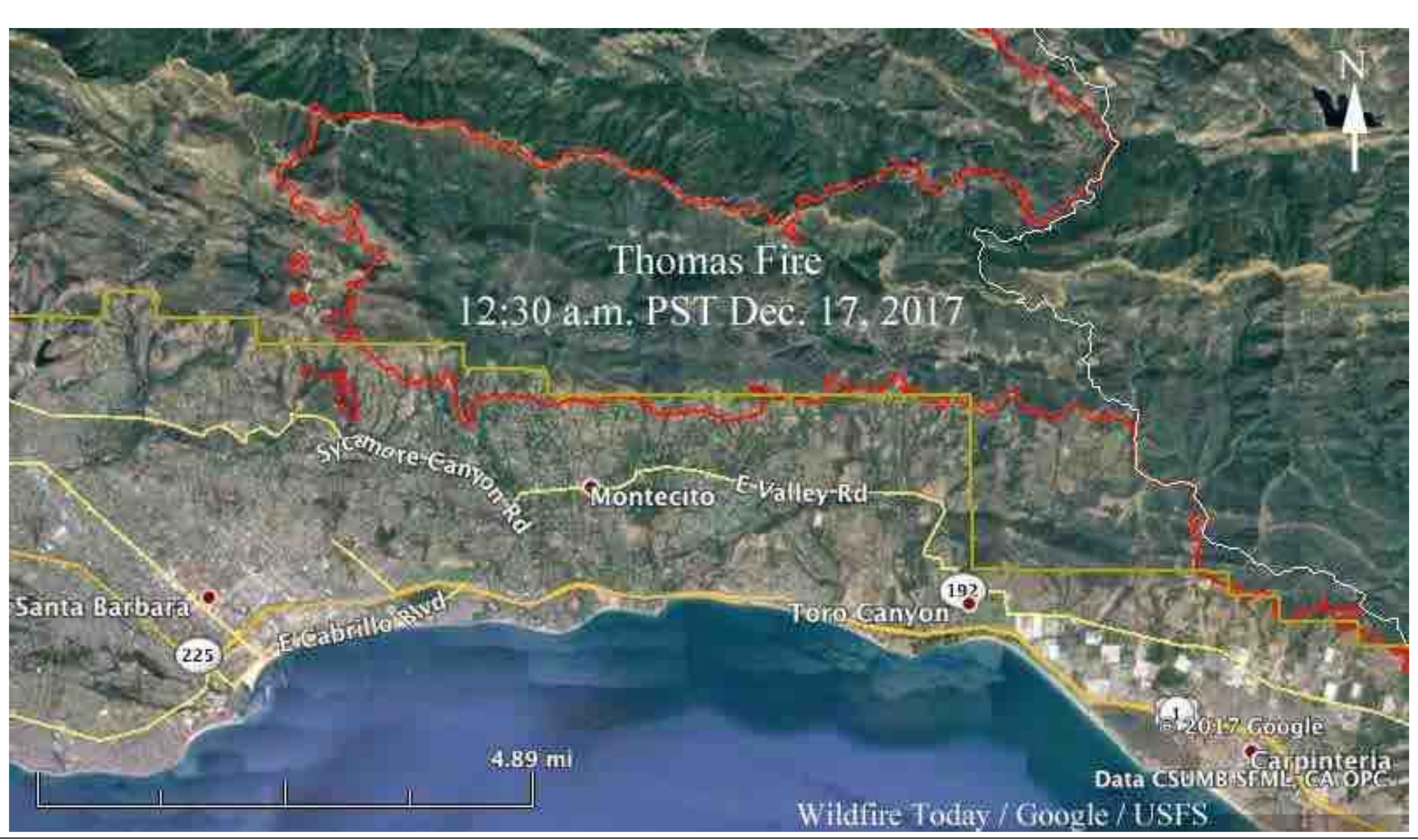


Romero Creek Drainage Basin

- Basin Area: 1.77 mi^2 (4.59 km^2)
- Flow Area: 0.24 mi^2 (0.63 km^2)

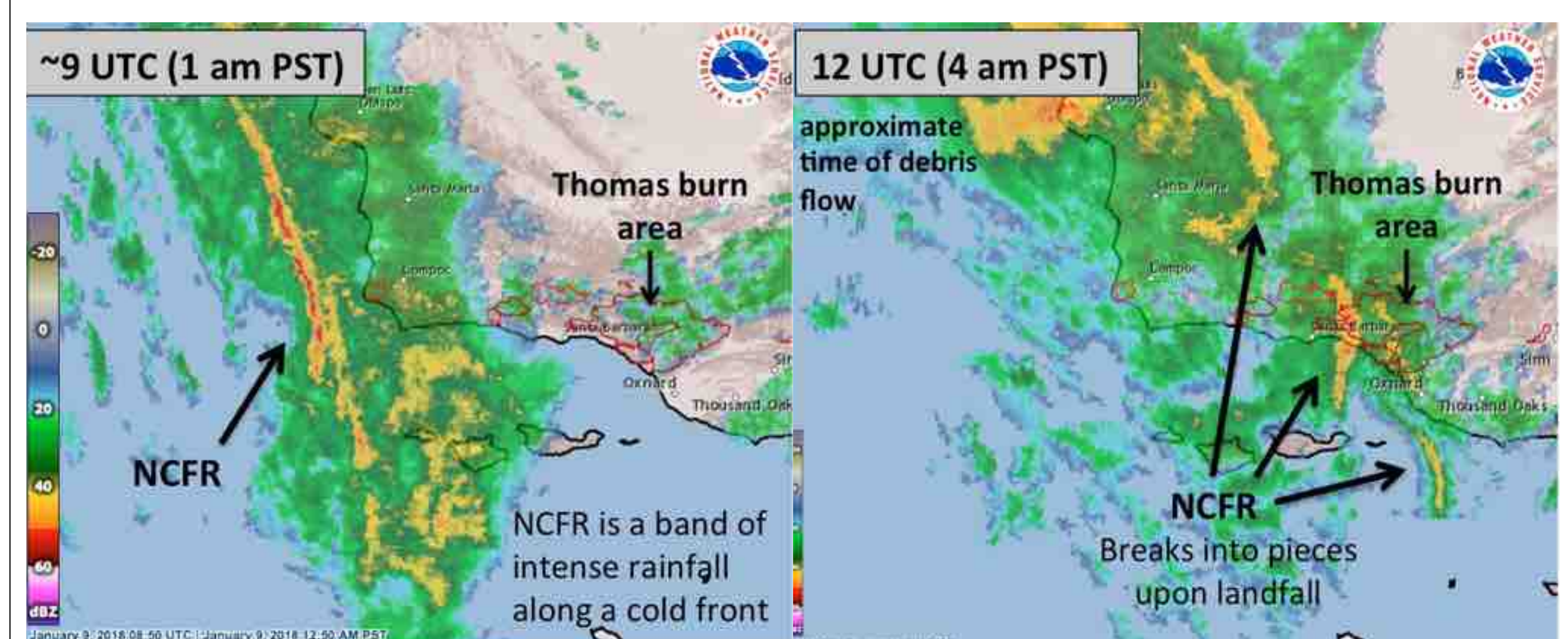
Thomas Fire Burn Area

- About 281,893 acres (~440 mi^2) burned



Rainfall and Other Causes

- Rainfall intensity for Montecito peaked at 13mm or 0.54inches of rain in 5 minutes.
- Montecito Water stated the rainfall intensity met or exceeded a 200 - year storm standard.
- USGS states that in Southern California "any rainstorm with >10mm per hour of rain poses a risk of producing debris flows.
- Montecito received over 1200% of the rainfall intensity to pose the risk of a debris flow in the area.



- Thomas fire burned completely through the Romero Creek drainage as observed on that map to the left by the dark brown colors of the mountains here.
  - Soil became less compact due to loss of plant roots and thus more susceptible to movement.

Thomas fire in the Montecito foothills.

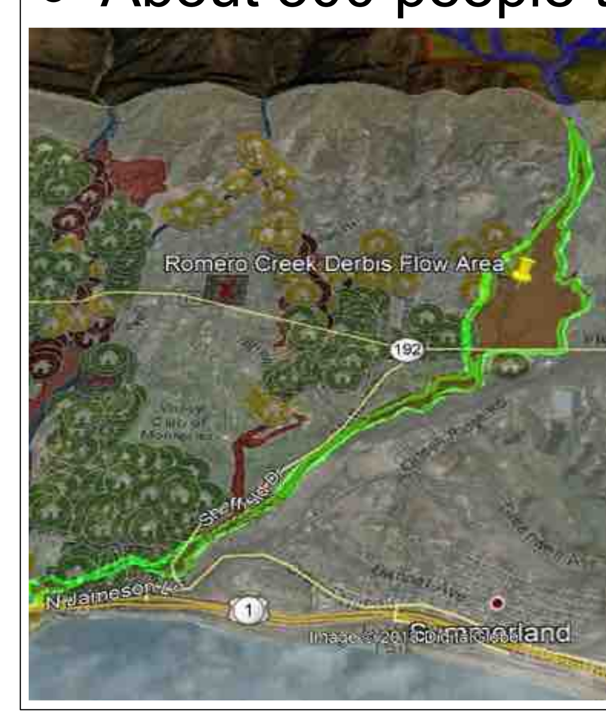
Thomas fire burn area in background after the debris flows.

Flow Characteristics

- Type: debris flow
- Height: <20 feet, exact height unknown
- Timing: at around 4 a.m. on January 9th, 2018
- Run-out: unknown

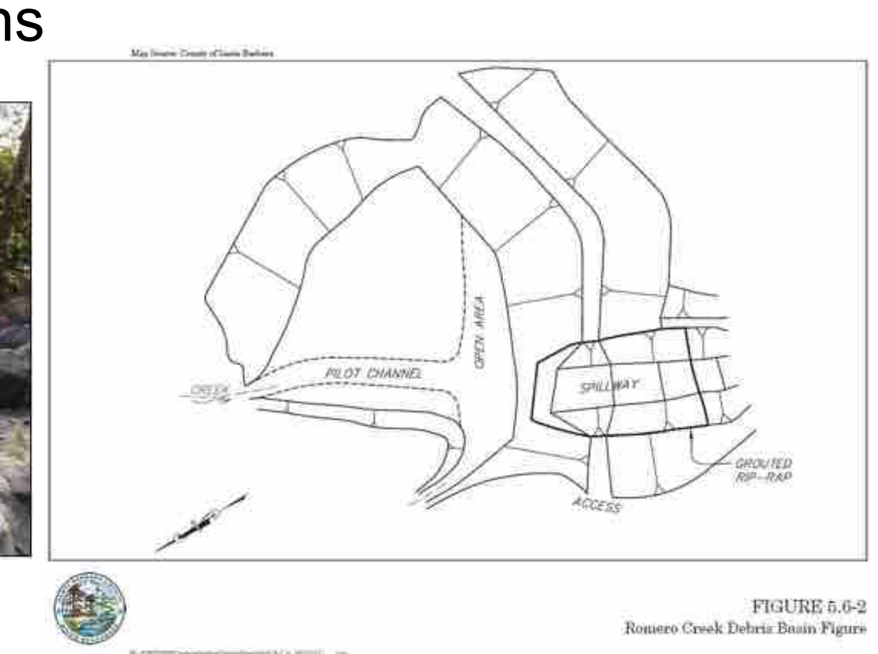
Aftermath

- At least 8 structures damaged, 3 destroyed with others seemingly undamaged (total ≥30 structures).
- About 300 people trapped in Romero Canyon.



Prevention Measures Implemented

- Romer Creek debris basin
  - Capable of containing 27,000 cubic yards of debris flow material
  - Built in 1971.
- Voluntary Evacuations



How Fire Increases Debris Flow Intensity

Andrew Barajas, Jennifer Bautista, Cindy De Jesus Bartolo,
Leticia Medina, Melony Robinson-Williams, Miguel Zamora Tamayo

490-Capstone

Introduction

- Hydrologic system
- Geomorphic system landscape
- Devastating debris flow
  - Intense rainfall
  - Poor municipal zoning
  - PRIMARY CAUSE: FIRE

Figure 1. Dec. 16 photo provided by the Santa Barbara County Fire Department, flames burn near power lines in Sycamore Canyon near West Mountain Drive in Montecito, Calif.

Fire History

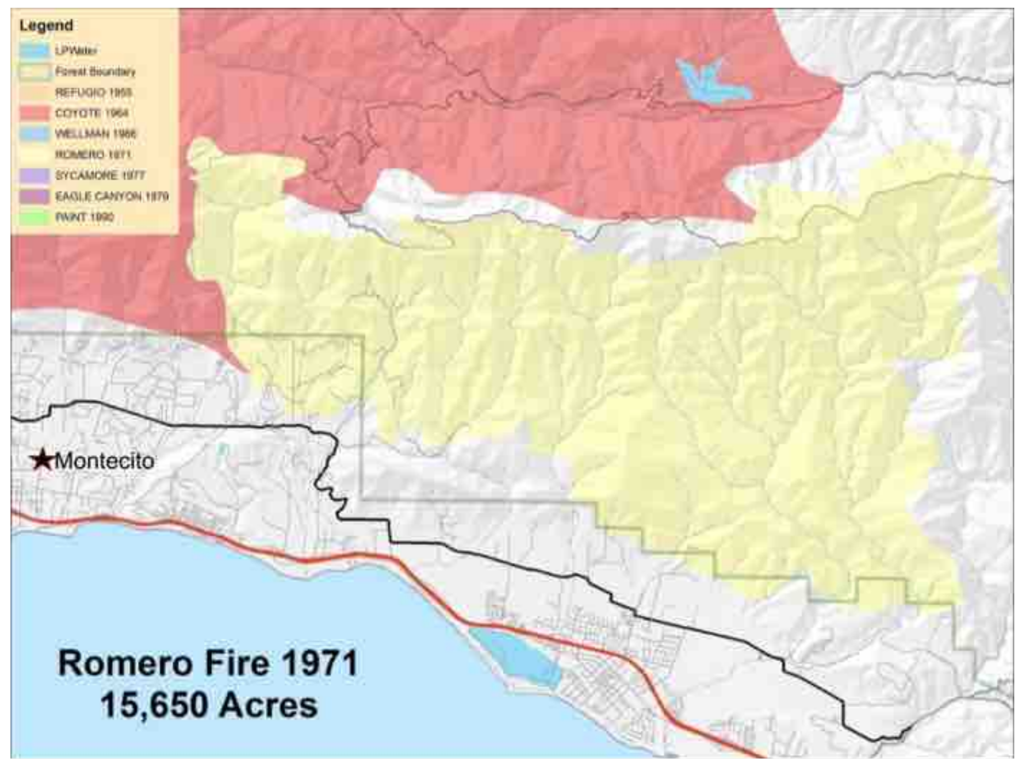
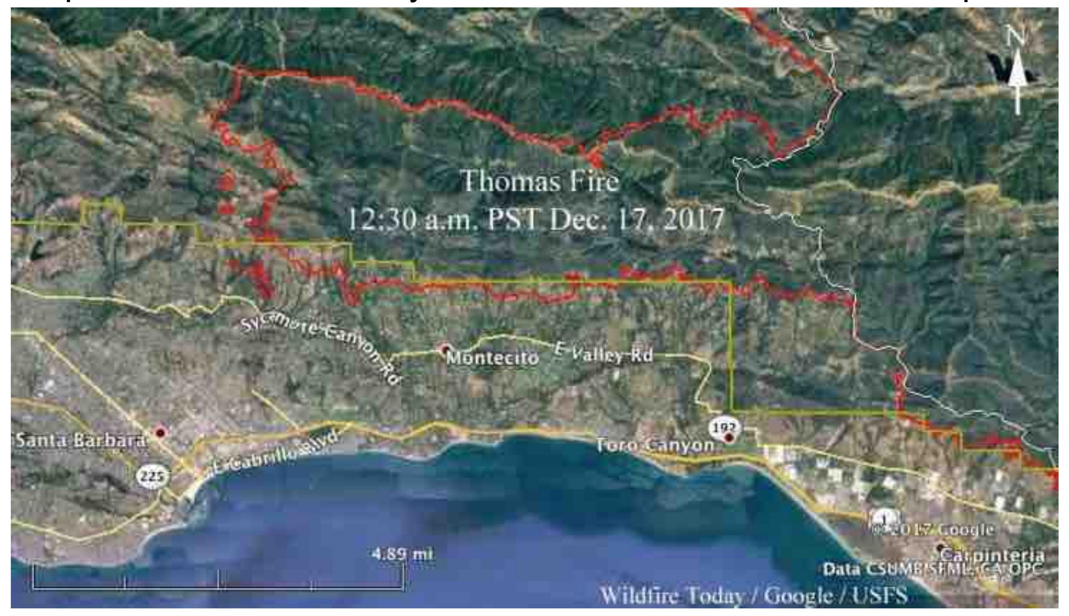


Figure 2. Maps of areas affected by wildfires near Montecito over the past 60 years.



Hydrophobic soil

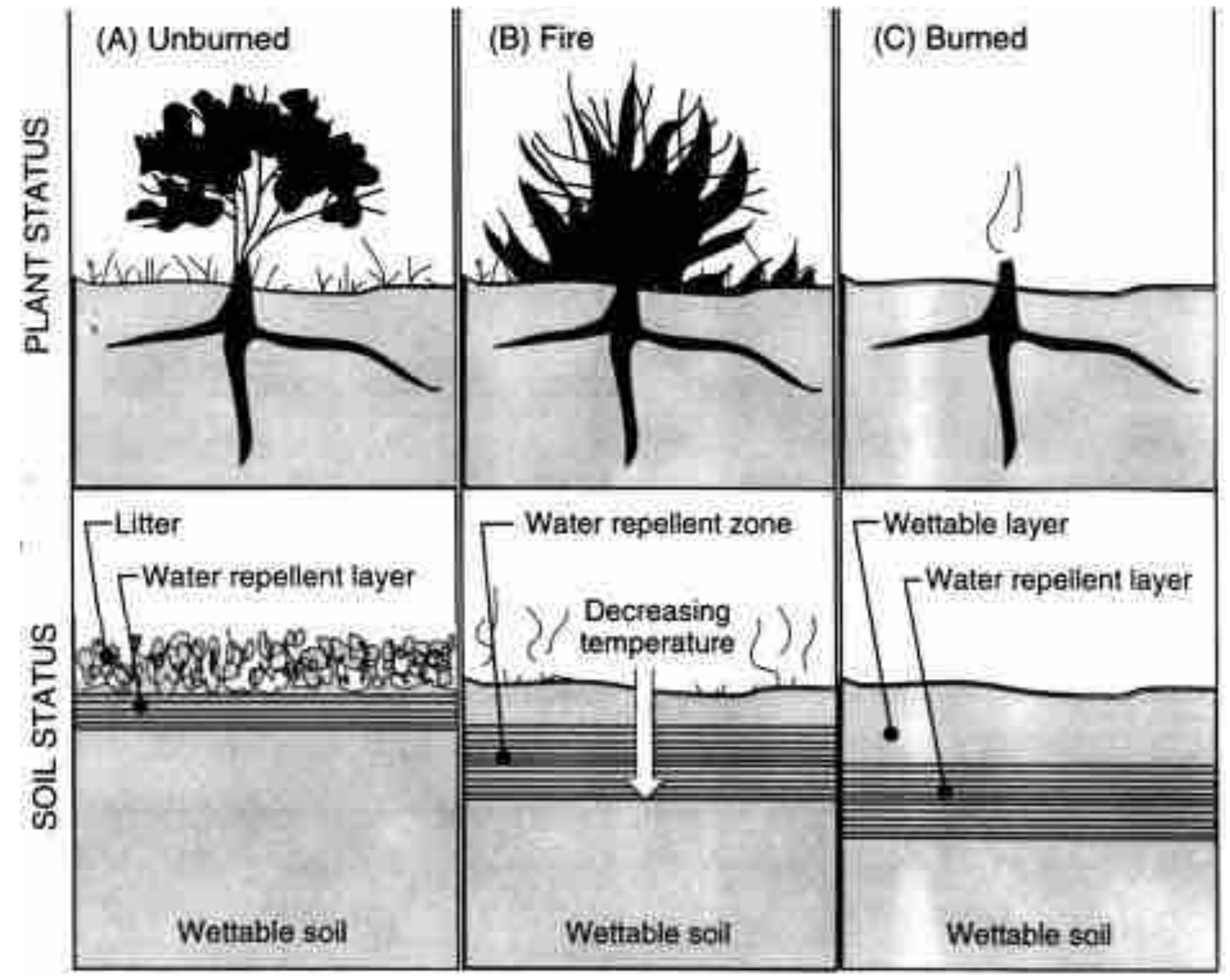


Figure 3. (A) Soil water repellency in unburned brush is found in the litter, duff, and mineral soil layers immediately beneath the shrub plants. (B) When fire burns, hydrophobic substances are vaporized, moving downward along temperature gradients. (C) After the fire has passed, a water repellent layer is present below and parallel to the soil surface on the burned area.

Figure 4. Water drops on the surface of a water-repellent aggregate

Post-Fire Infiltration and Erosion Rates

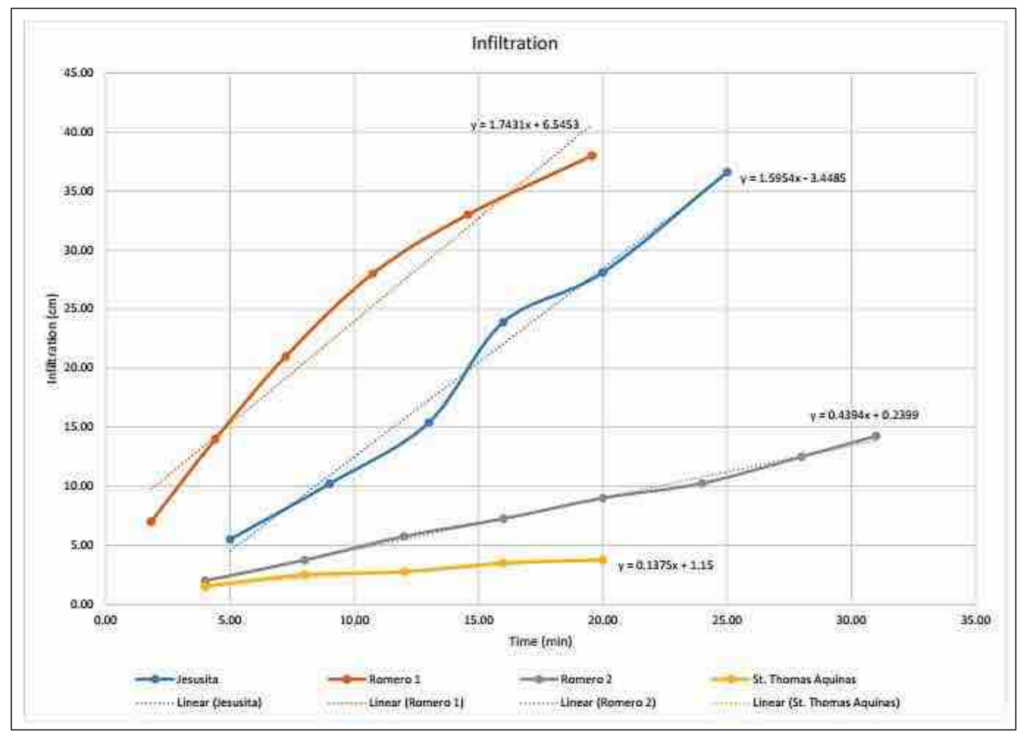


Figure 5. Graph of infiltration data collected in field from 3 recently burned areas (Romero 1, Romero 2, St. Thomas Aquinas) and 1 non-recently burned control area (Jesusita).

- Post-Fire Infiltration and Erosion rates are influenced by fire due to:
  - Water Repellency
  - Overland Flow
  - Removal of Vegetation

Fire Effects on Vegetation

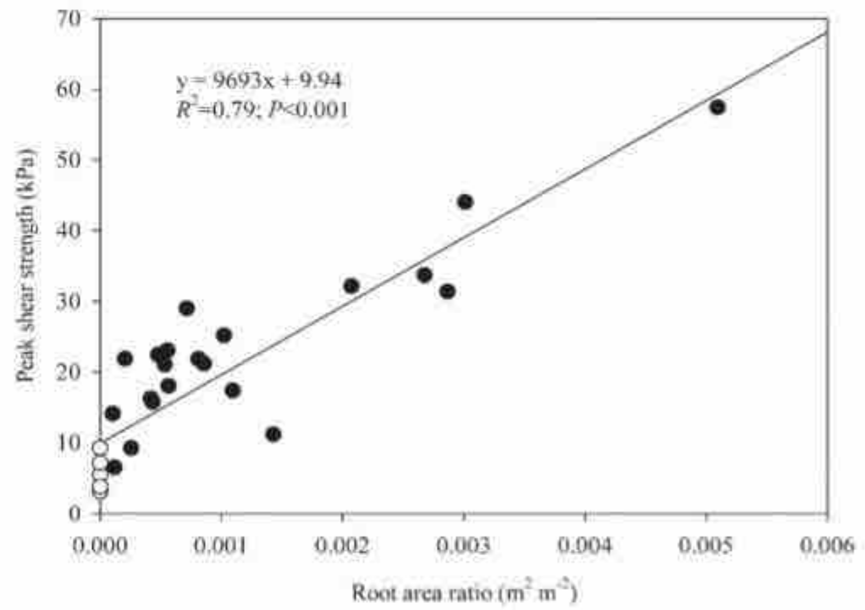


Figure 6. Graph showing correlation between root enforcement and soil shear strength.

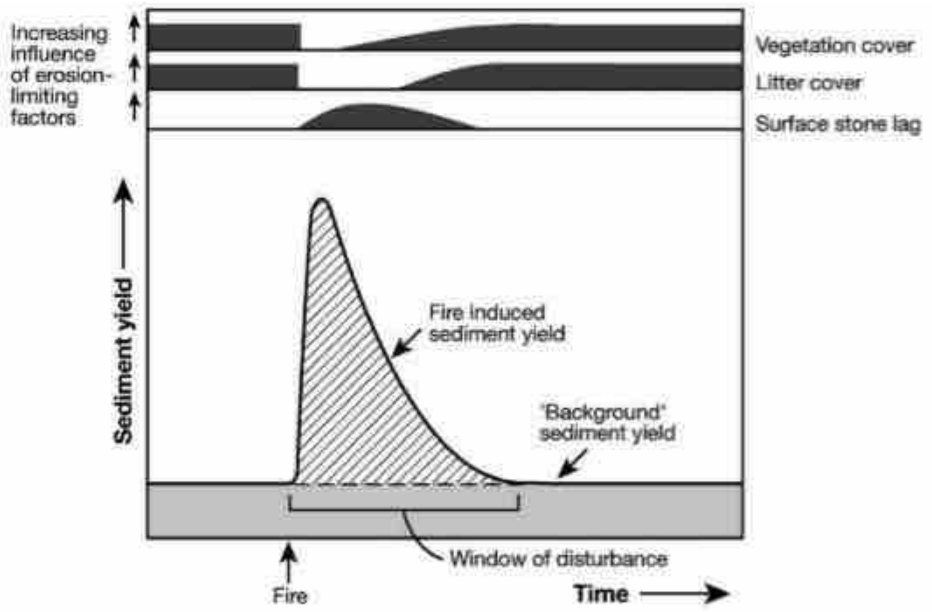


Figure 7. Summary diagram showing the range of factors affecting post-fire erosion.

Breakdown of rock

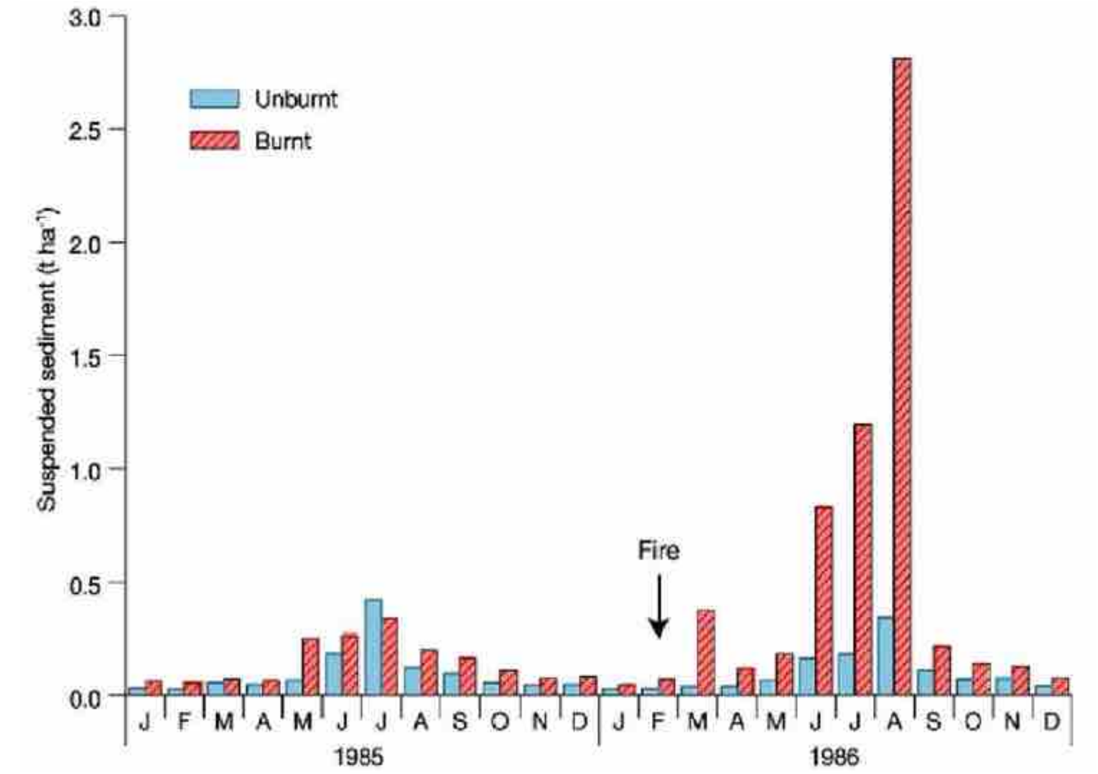
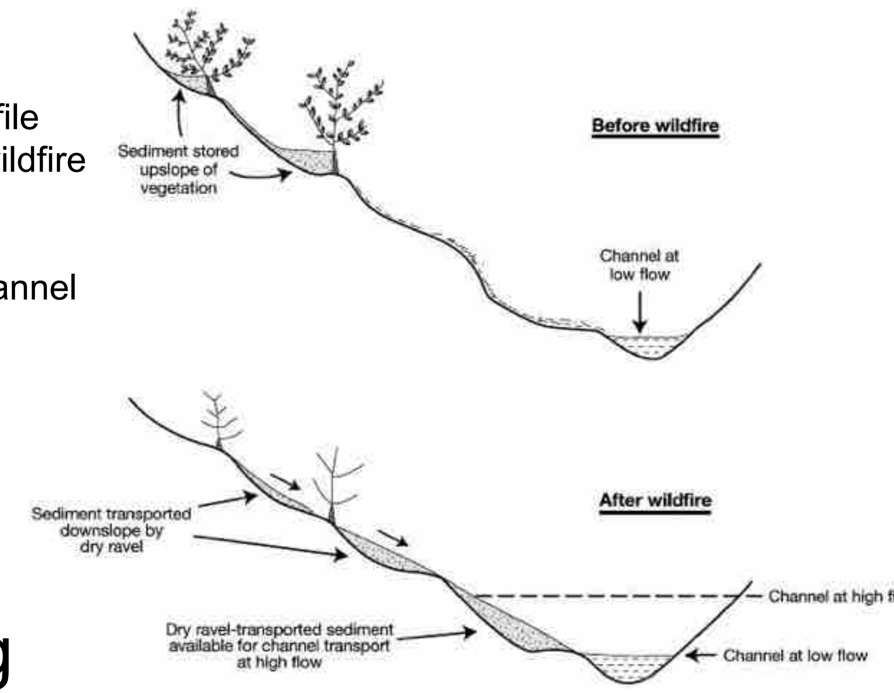


Figure 8. Monthly suspended sediment yields for paired catchments, Western Cape, South Africa before and after a high-severity wildfire in February 1986.

Figure 9. Hillslope profile showing the effect of wildfire on vegetation and downslope transfer of sediment to stream channel by dry ravel.



- Spalling
- Fracturing
- Increase of dry ravel
- Increase of suspended sediment

Conclusion

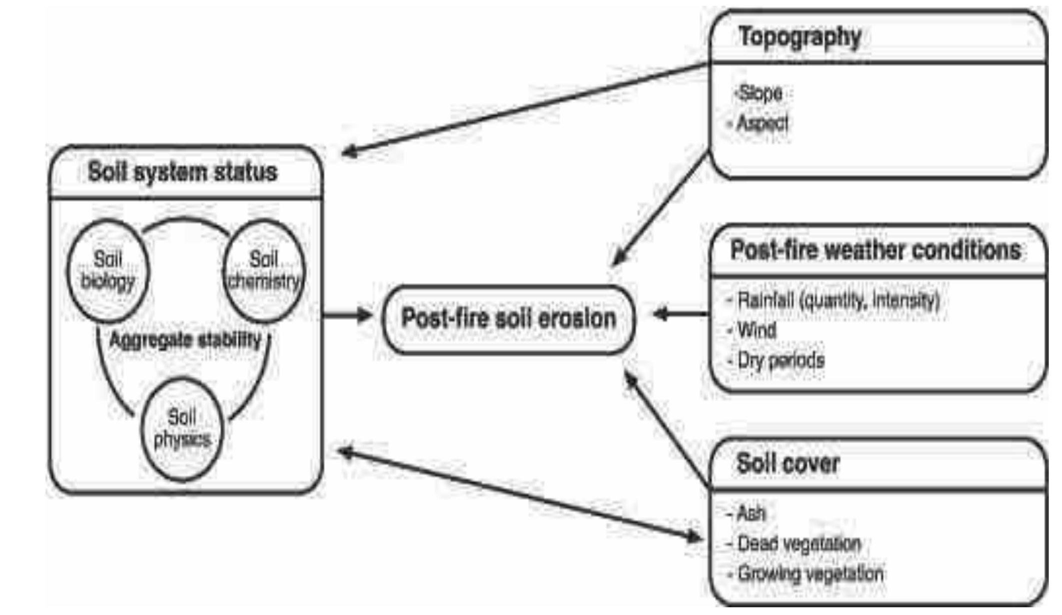


Figure 10. Summary diagram showing the range of factors affecting post-fire erosion.

References

Shakesby, R.A. and Doerr, S.H., 2006, Wildfire as a hydrological and geomorphological agent: Earth-Science Reviews, v. 74, p. 269—307, doi.org/10.1016/j.earscirev.2005.10.006

DeBano, L.F., 2000, The role of fire and soil heating on water repellency in wildland environments: a review: Journal of hydrology, v. 231, p. 195-206.

Mataix-Solera, J., Cerdā, A., Arcenegui, V., Jordán, A., and Zavala, L., 2011, Fire effects on soil aggregation: a review: Earth-Science Reviews, v. 109, no. 1-2, p. 44-60.

Shakesby, R., and Doerr, S., 2006, Wildfire as a hydrological and geomorphological agent: Earth-Science Reviews, v. 74, no. 3-4, p. 269-307.

49 PALMS OASIS, JOSHUA TREE

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Armen Aghakiant, Cindy De Jesus Bartolo, Bailey Rossi, Miguel Zamora Tamayo

Location:

Mojave Desert: Joshua Tree, Oasis Trail

Formation and Texture:

Formation: Due to various conditions, we determined that the rocks we studied at this location to be Mesozoic era intrusive igneous rocks formed from subduction activity in the area during that time period. Some of these included:

- Altitude
- Minerals present
- Texture

Texture and Color: Although the some of the minerals were difficult to distinguish from each other the rock was:

- White and light grey in color, weathering to a darker grey
- Medium-grained
- Equigranular
- No fabric
- Contained: garnets, muscovite, biotite, quartz, plagioclase, and potassium feldspars

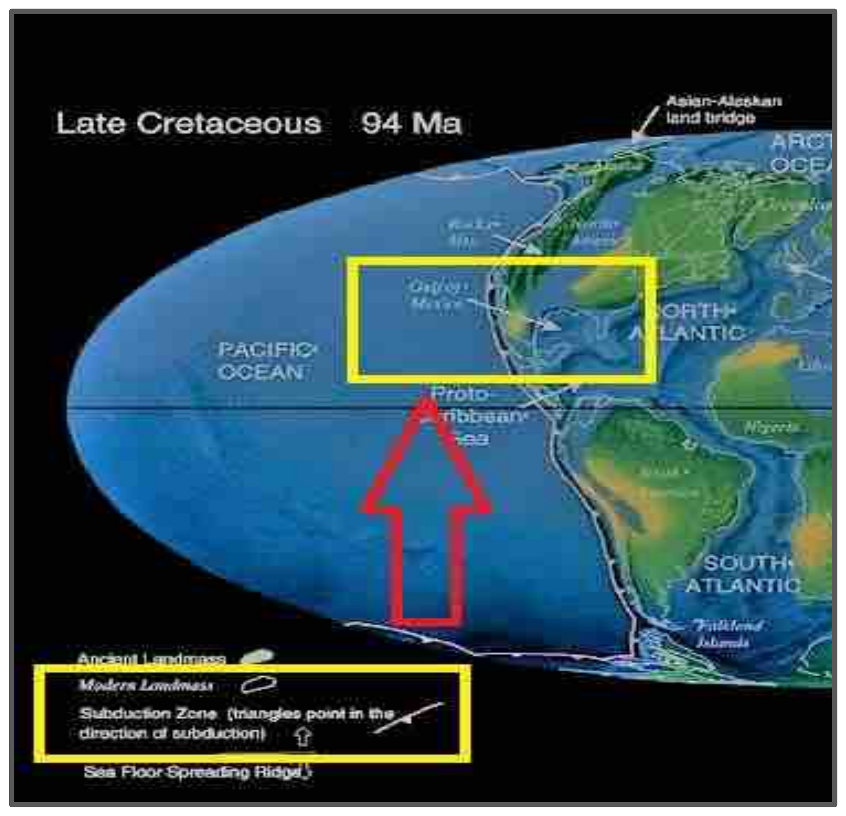


Figure 1

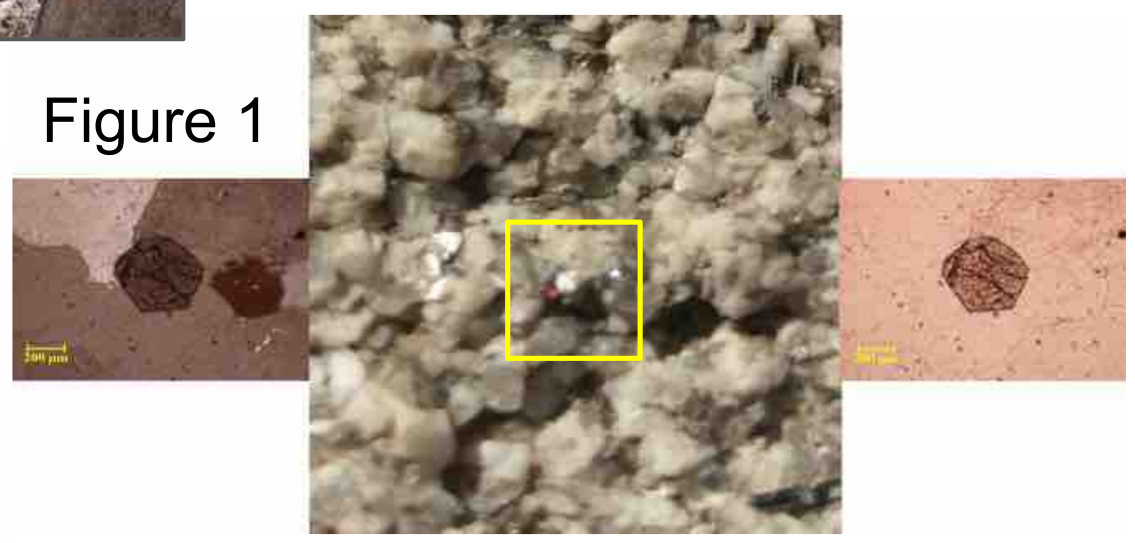
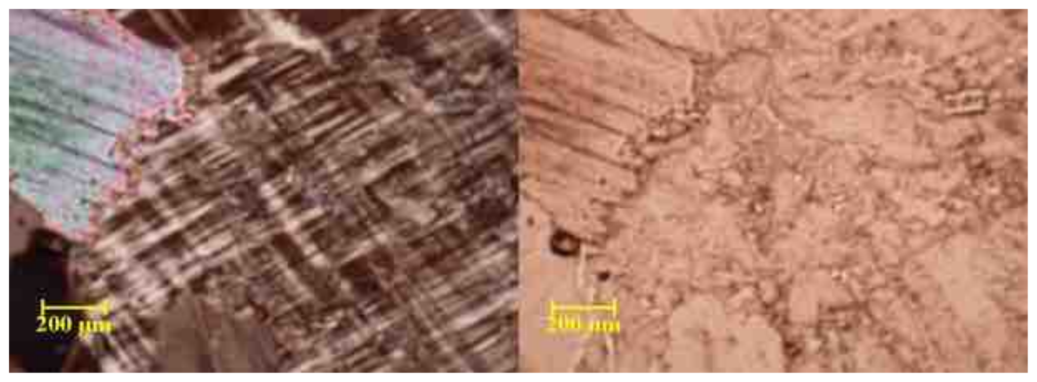
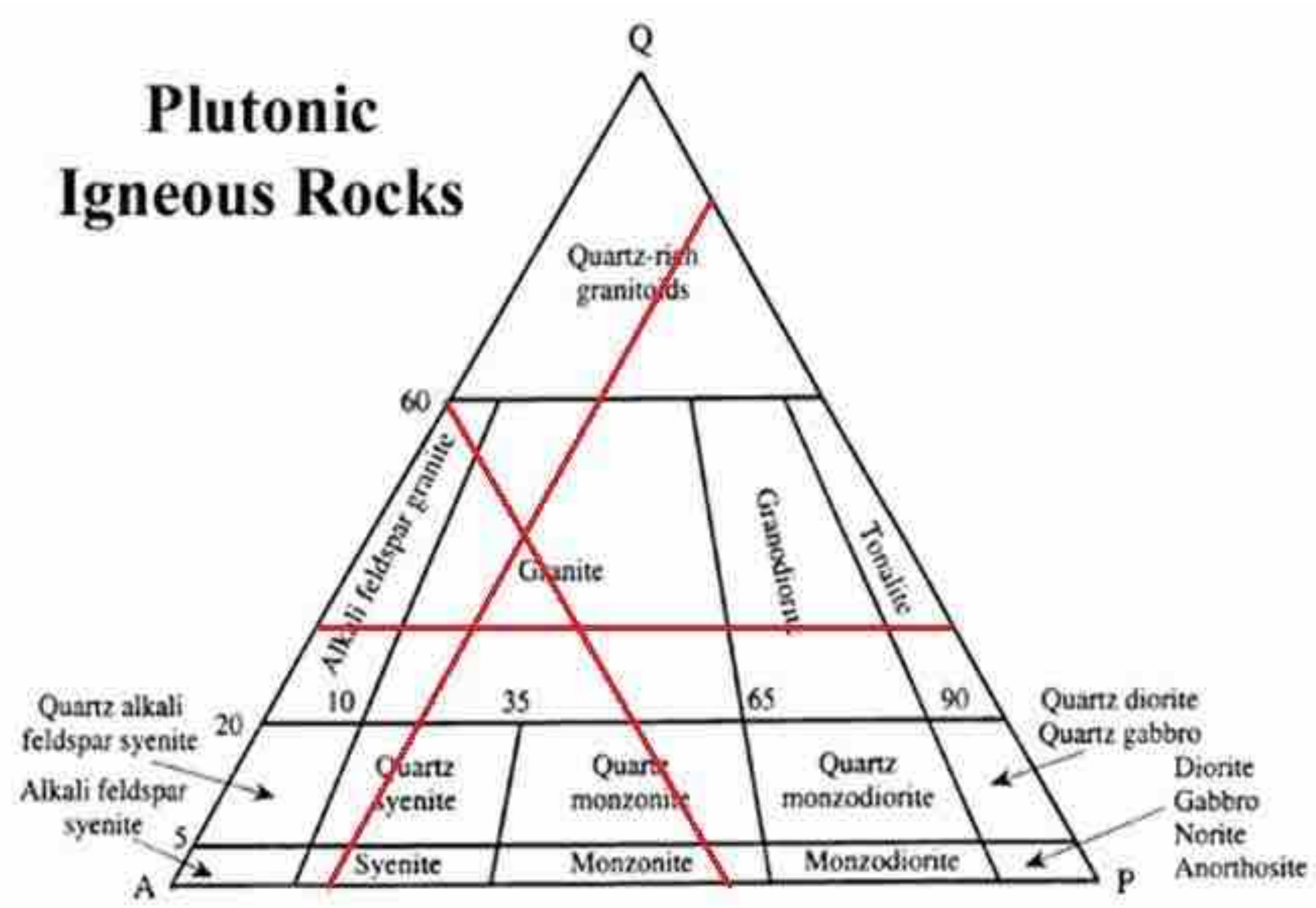


Figure 2





Rock Type:

QAP abundances:
- 30% Q
- 40%A
- 30% P

Rock Name:
- Granite

Unique features:
- Muscovite, biotite, and garnets present in rock.
- High Aluminum content tells us this rock is felsic and peraluminous: a common characteristic of crustal melts

Photomicrographs:

Figure 1:

Garnet $X_3Y_2(SiO_4)_3$

Silicate mineral
Occurrence: Metamorphic, Igneous, and Sedimentary rocks
Luster: Vitreous
No cleavage
Hardness: 6.5 - 7.5
Relief: High
Isotropic Mineral

Figure 2:

Muscovite $KAl_2(Si_3AlO_{10})(OH)_2$

Silicate Mineral
Most common mineral of the mica group
Sheet Silicate
Important rock-forming mineral of igneous, metamorphic, and sedimentary rocks
Luster: Pearly to vitreous
Cleavage: One Perfect
Hardness: 2.5 – 3
Relief: Moderate

Microcline $K(AlSi_3O_8)$

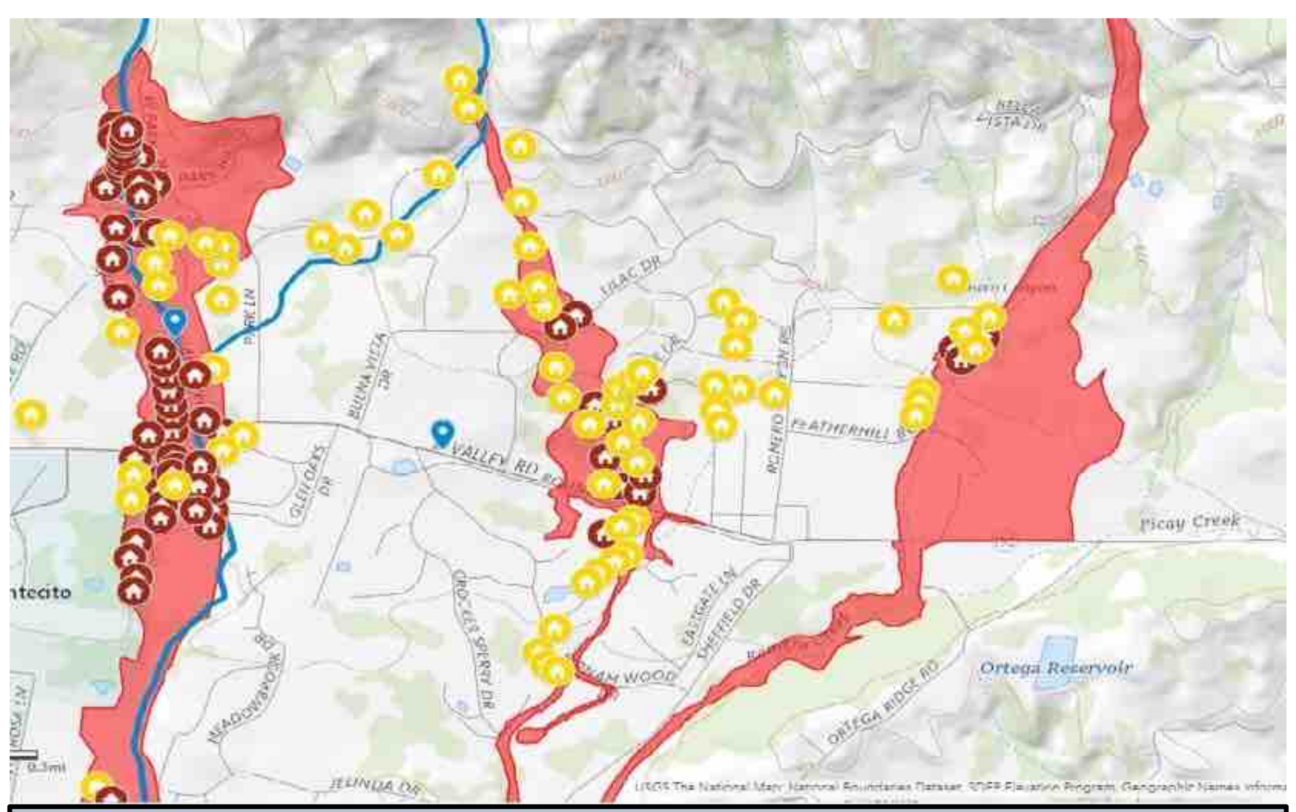
Potassium Aluminum Silicate
Framework Mineral
Occurrence: Metamorphic, Igneous, and Sedimentary rocks
Luster: Vitreous
Cleavage: One Perfect

Buena Vista Creek

490-Trip

Armen Aghakiant, Marshal Mcgurk, Cindy dejesus Bartolo, Melony Robinson Williams

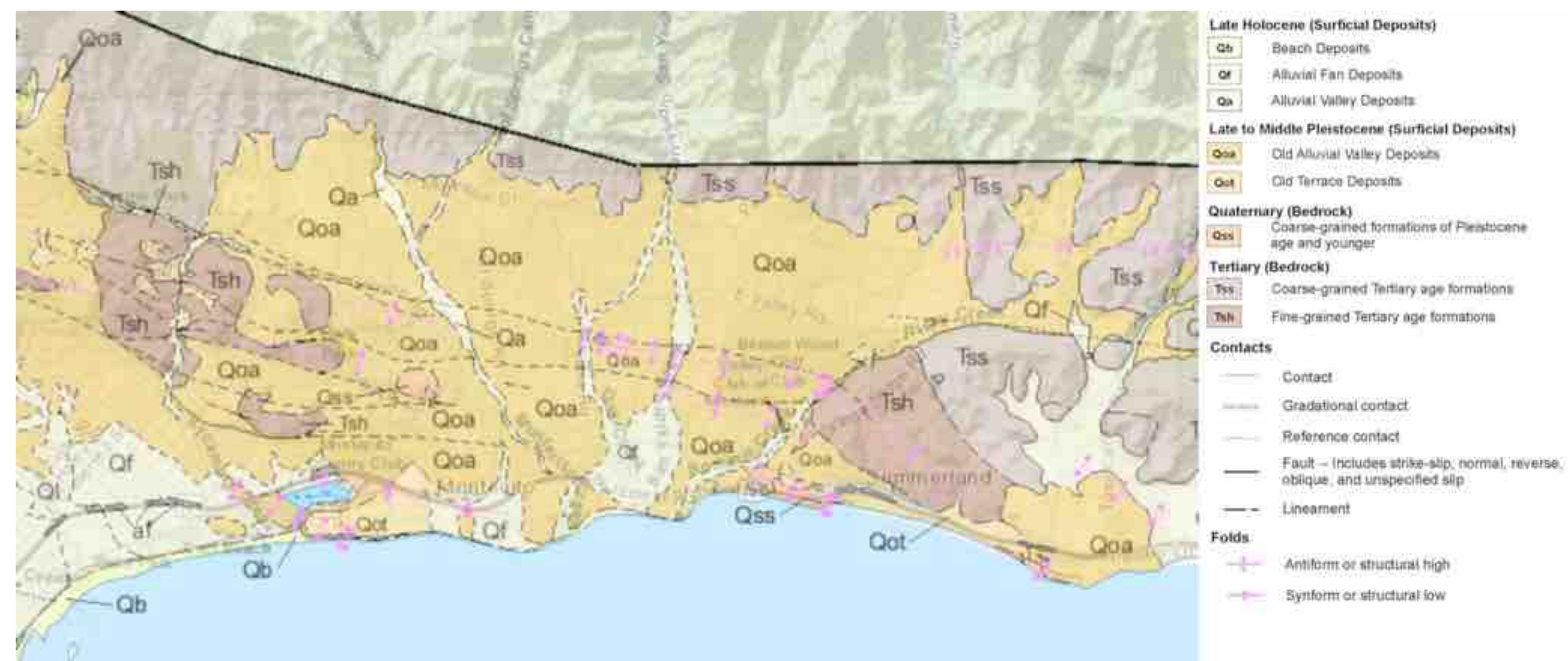
Buena Vista Creek is a small watershed that originates in the foot of the Santa Ynez Mountains and drains a 1,472-acre area capable of producing 2,800 cfs during a 100 year storm event. Buena Vista Creek is characterized by dry, rocky substrate and steep, deep banks with residential lawns and open space immediately adjacent to the top of both banks.



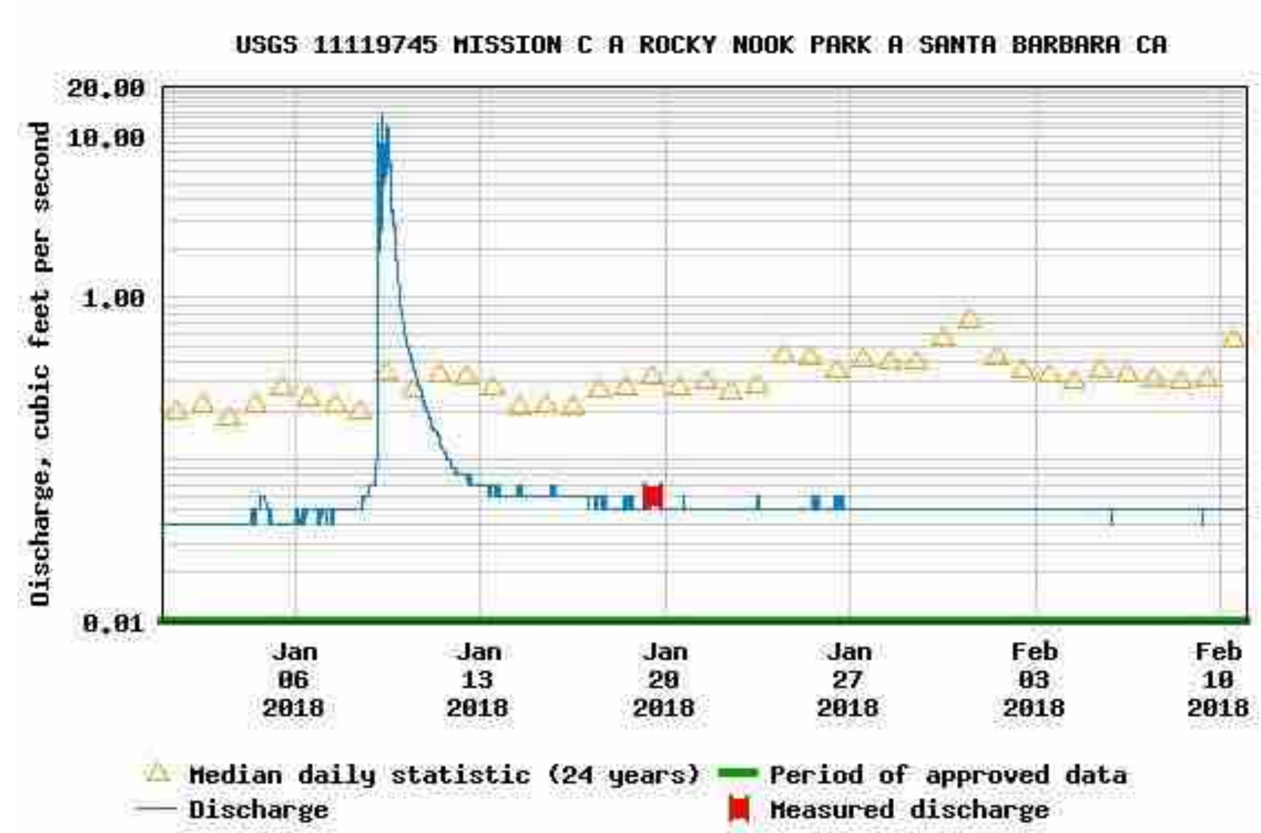
Buena Vista creek debris flow disaster assessment map. Approximately 32 Homes directly on the drainage basin were damaged. The yellow color indicates mild damage while the red indicates major damage.

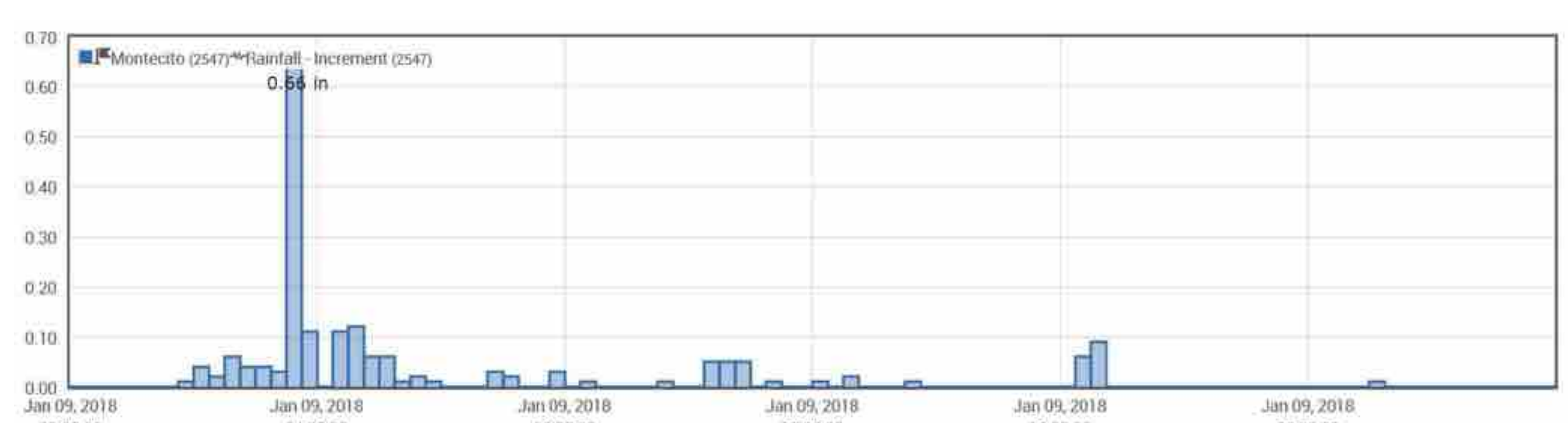
USGS Montecito Landslide Risk Estimate Map

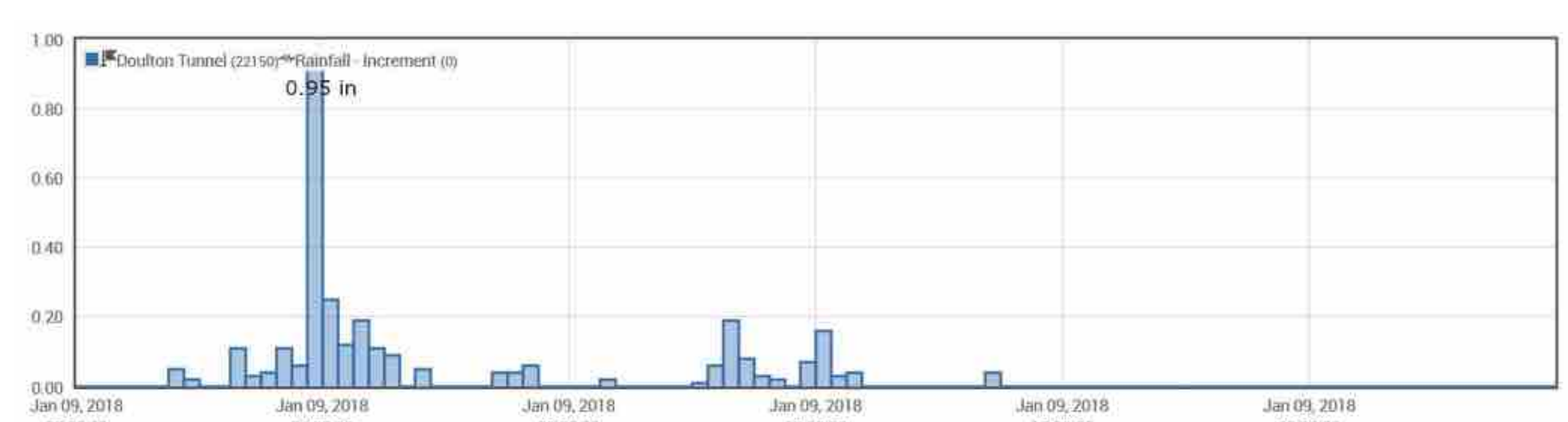
Model estimating probability and volume of debris flow initiation after Thomas fire. Wildfire significantly decreases the threshold of the soil to where even the modest rainstorms will initiate debris flows.



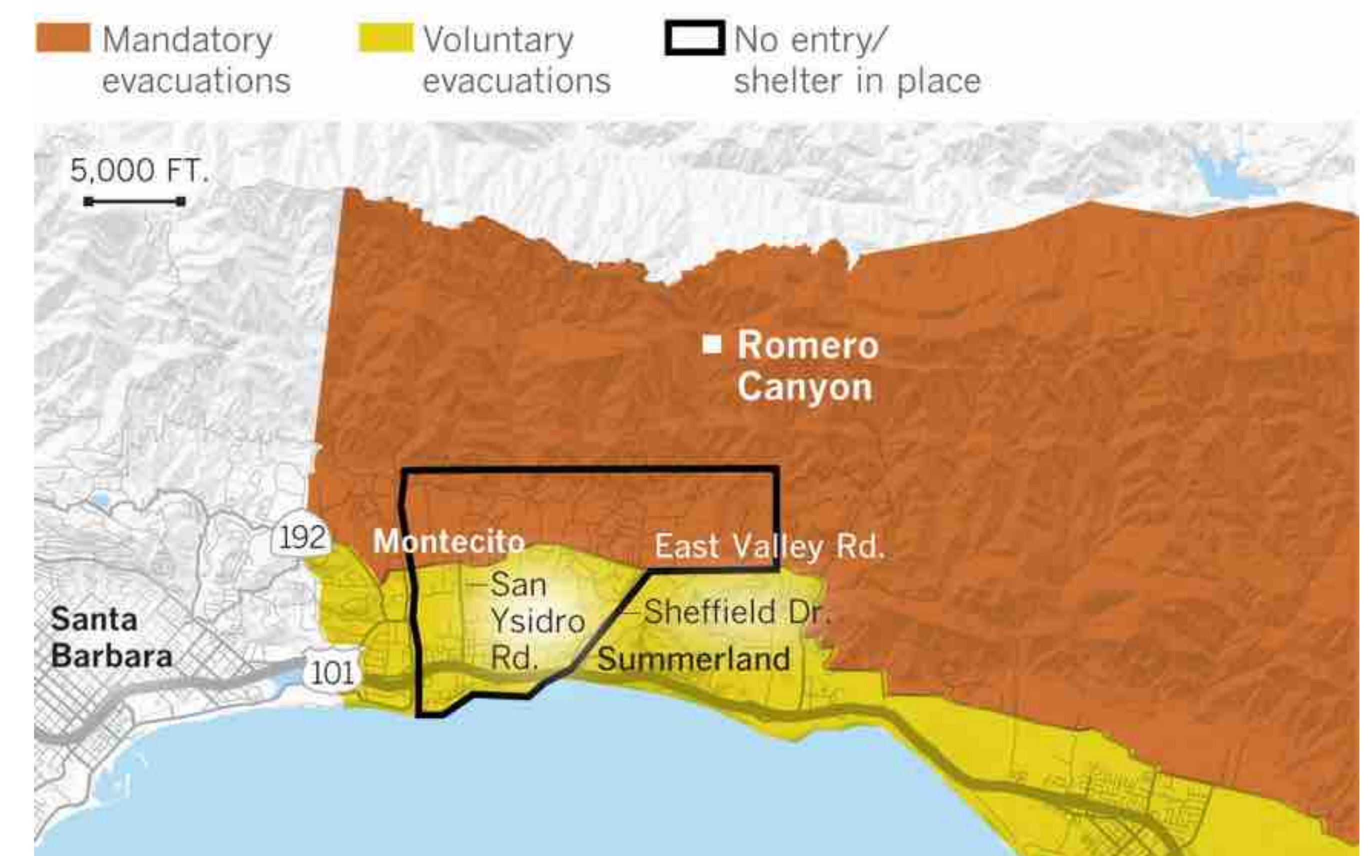
Tss includes units of shale and sandstone is resistive topping the tallest ridges and forming the steepest faces. Between the beds of sandstone are non-resistive shale which quickly erodes forming many of the slopes of the area, these readily form soils and have most of the vegetation in the area on them. Qf are recent deposits and have contributions from previous debris flows.







The total for montecito precipitation rates and discharge on the day of the storm. At peak intensity between 26000 and 40000 cubic meters of water entered the basin in just 15 minutes, which is approximately an olympic swimming pool of water every minute.



This figure maps montecito evacuation zone

Mudslide cleanup continues in Montecito on Jan. 11, 2018, California Task Force 8 of San Diego searches a property for victims on East Valley Road.

East Valley Road. Montecito, Marc Phillips slogged up and down East Valley Road Quote from local resident;"It looks like there was never a house there, but it was."

Failures in Mitigating Damage Caused by the Montecito Debris Flow

Armen Aghakiant, Clarissa Jones, Marshal McGurk

Eduardo Navarro, Isabel Pina

490-Capstone

Introduction

Thomas Fire and Montecito Landslide

On December 4th, 2017, a fast moving active brush fire driven by Santa Ana Winds started North of Santa Paula along Highway 150. The Thomas Fire burned 281,893 acres and was 100% contained on January 12th, 2018. The Fire destroyed 1,063 structures and damaged another 280 structures. The Southern California Edison utility company says its electrical equipment is at least partly to blame for starting the deadly Thomas Fire. On January 9th, 2018, after intense rain, a debris flow occurred which caused significant damage to structures (over $421 million) and lead to 21 deaths.

Damages Caused due to:

- Communication Failure
- Insufficient Drainage Basins
- Poor Evacuation Plan
- City Zoning

Communication Failure

- Santa Barbara County Officials
- Debris Flow evacuation boundaries
- Evacuation Decisions
- Fire Protection Plan
- Emergency Management- Responsibilities and Duties

Figure. Evacuation map that the county issued with conflicting evacuation warnings

Insufficient Drainage Basin

Drainage Basins built decades ago were not adequate enough to lessen the damage caused by the debris flow.

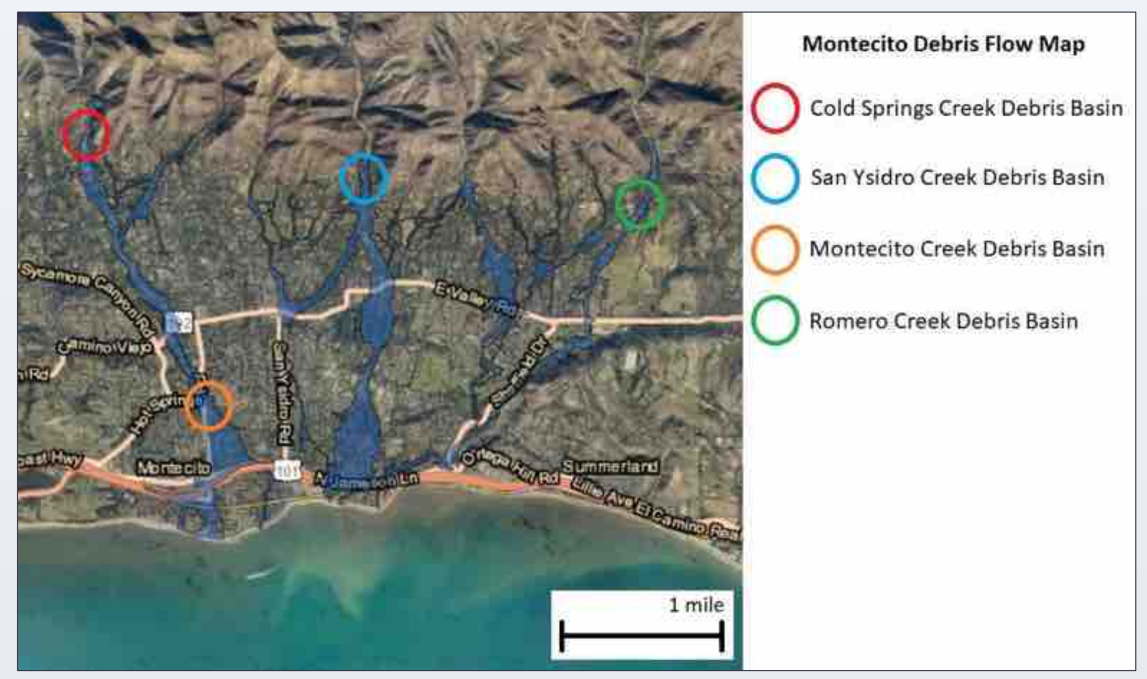


Figure. Map of the Montecito debris flow and location of drainage basins.

Debris Basins	Year Built	Designed Capacity	Updated Calculated Capacity
Cold Springs Creek Debris Basin	1964	20,000 yd^3	12,775 yd^3
San Ysidro Creek Debris Basin	1964	11,000 yd^3	7,945 yd^3
Montecito Creek Debris Basin	2002	5,500 yd^3	-
Romero Creek Debris Basin	1971	25,400 yd^3	8,360 yd^3
Santa Monica Creek Debris Basin	1977	208,000 yd^3	-

Table. Debris basins in the Montecito area with the originally designed capacity for debris and updated capacity calculated in 2005.

Figure. San Ysidro Creek Debris Basin (left) Santa Monica Debris Basin (right).

"Public work crews in Ventura and Santa Barbara counties are frantically clearing out every debris basin and storm drain possible, because the fire has left behind another threat — mudslides." - Paul Vercammen

Despite the Santa Barbara County's efforts to clear the debris basins the damage from the debris flow continued to the ocean.

Evacuation Problems

The official evacuation orders were given the morning of January 7th by police officers going door to door. Of the 1,400 residents asked to evacuate from the mandatory evacuation zone 200 residents said they'd leave.

Figure. Disaster map with debris flow hazard map overlayed. Colored in orange is the mandatory evacuation zone and from that border to the coast is the voluntary evacuation zone put into place by Santa Barbara County. Disaster map shows location of fatalities (black), missing people's last location (brown), people rescued (yellow), houses destroyed/majorly damaged (red).

Zoning

- Santa Barbara County prohibits development, expansion, and redevelopment in 100 year flood zones(Santa Barbara County Code, May 2006)
- Inadequate risk assessments

Figure. Section including Montecito, from the Geologic Map of Santa Barbara Coastal Plain Area.

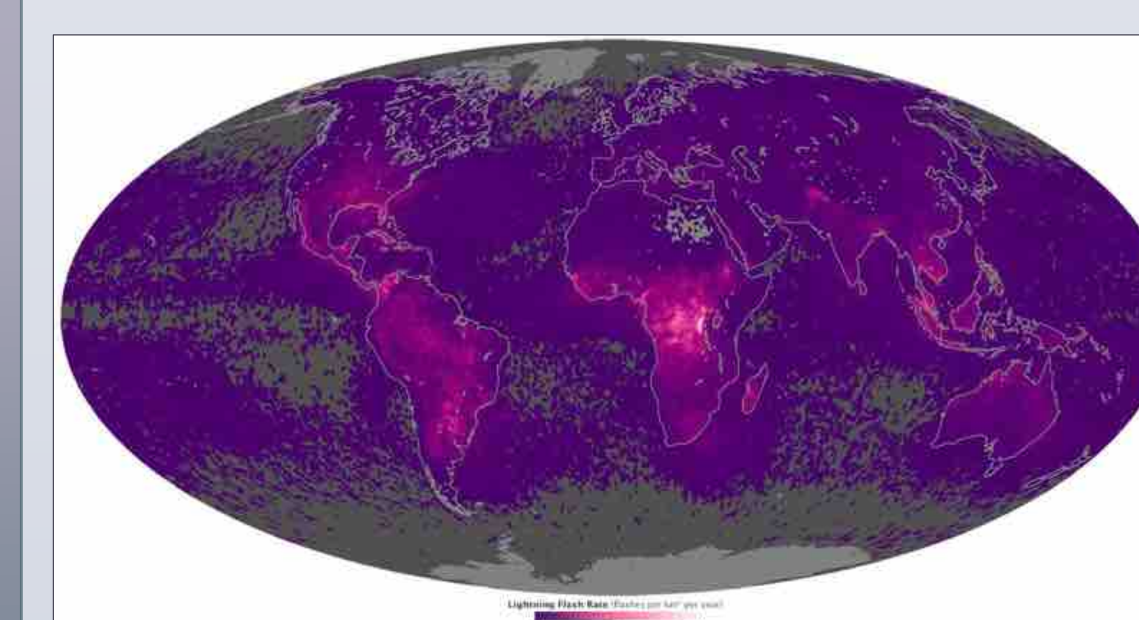
Figure. Damaged home in the immediate vicinity of the debris flow path in Montecito

Distortions in Risk Assessment

- FEMA Flood Insurance Risk Maps don't reflect debris flow risk (Hydrology: Rainfall-Runoff Analysis, Feb 2018)
- Debris flows account for a large share of sedimentation (McCoy, 2015)
- Insurance rates likely don't reflect this risk
- Insurance rates can dissuade, communicate risk and even prohibit development in certain cases
- FEMA is updating it's risk maps for Montecito will complete in 4-5 years

Natural vs. Anthropogenic Fire

- 63% of fires are anthropogenically caused Malamud et al. 2005
- Lightning causes 99% of natural fires Malamud et al. 2005
- California experiences very little lightning NASA Earth Observatory
- Santa Ana wind conditions are less likely during dry lightning events
- Fire conditions in Southern California are more frequent and at more dangerous times than in the natural order
- Mud flows may be more common due to worse than normal anthropogenic fires.



References

CNN, Paul Vercammen. "Mudslide Danger Replaces Fire Threat in SoCal." CNN. Accessed December 6, 2018. https://www.cnn.com/2018/01/02/us/california-thomas-fire-mudslide-threat/index.html.

FEMA flood map service center, accessed December 6, 2018 https://msc.fema.gov/portal/search?AddressQuery=montecito#searchresultsanchor

"Finalized Damage Inspections 1/18/18." Accessed December 6, 2018. https://sbc-gis.maps.arcgis.com/apps/webappviewer/index.html?id=ee848a57d8b2416eb2802da300df5b6e.

Hydrology: Rainfall-Runoff Analysis, Guidance for Flood Risk Analysis and Mapping, FEMA, February 2018 https://www.fema.gov/media-library-data/1520964160255-7c49e1753d0b2634e0c5fb4999459374/Hydrologic_Rainfall_Runoff_Analysis_Feb_2018.pdf

Hydraulics: Two-Dimensional Analysis, Guidance for Flood Risk Analysis and Mapping, FEMA, November 2016 https://www.fema.gov/media-library-data/1484864685342-42d21ccf2d87c2aac95ea1d7ab6798eb/Hydraulics_TwoDimensionalAnalyses_Nov_2016.pdf

General Hydraulics Considerations, Guidance for Flood Risk Analysis and Mapping, FEMA, November 2016 https://www.fema.gov/media-library-data/1484864685333-42d21ccf2d87c2aac95ea1d7ab6798eb/General_Hydraulics_Guidance_Nov_2016.pdf

Malamud, B., Millington, J., & Perry, G. (2005). Characterizing wildfire regimes in the United States. *Proceedings of the National Academy of Sciences of the United States of America*, *102*(13), 4694–4699. https://doi.org/10.1073/pnas.0500880102

Mccoy, S. (2015). RESEARCH FOCUS: Infrequent, large-magnitude debris flows are important agents of landscape change. *Geology*, *43*(5), 463–464. https://doi.org/10.1130/focus052015.1

Minor, S.A., Kellogg, K.S., Stanley, R.G., Gurrola, L.D., Keller, E.A., and Brandt, T.R., 2009, Geologic Map of the Santa Barbara Coastal Plain Area, Santa Barbara County, California: U.S. Geological Survey Scientific Investigations Map 3001, scale 1:25,000, 1 sheet, pamphlet, 38 p.

NASA Earth Observatory Global Lightning Activity, Accessed December 6, 2018 https://earthobservatory.nasa.gov/images/85600/global-lightning-activity

NPR, Emily Sullivan. "Southern California Edison Says Its Equipment May Have Helped Start Thomas Fire" Accessed December 5, 2018 https://www.npr.org/2018/10/31/662399218/southern-california-edison-says-it-is-partly-to-blame-for-thomas-fire

Santa Barbara County Code, Article IV of Chapter 35, Montecito Zoning Ordinance, County of Santa Barbara, May 2006, Accessed December 6, 2018 http://sbcountyplanning.org/PDF/A/Article%20IV.pdf

Why Montecito's mudslide victims don't need flood insurance to recover their losses. (n.d.). Retrieved December 6, 2018, from https://www.latimes.com/opinion/readersreact/la-ol-le-montecito-mudslides-flood-insurance-20180119-story.html

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A MINERALOGICAL INVESTIGATION OF INTERMEDIATE INTRUSIVE IGNEOUS ROCKS IN JOSHUA TREE NATIONAL PARK

Adam Brackman, Hunter Burnett, Oscar Menjivar, Christina Tristan

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INTRODUCTION/OVERVIEW

Joshua Tree National Park is known for its visually appealing rocks composed mostly of felsic igneous and metamorphic rock outcrops. These rocks were emplaced and metamorphosed over millions of years, then eroded by surficial processes to create the striking outcrops visible today[1].

A much smaller number of outcrops display a significantly more mafic composition than the bulk of the park, and our group's study focused on one such outcrop [2].

Here, we investigate the composition and possible mechanisms of emplacement for this intrusive intermediate igneous rock based upon prior research, field sampling, and thin section examination.

OUTCROP FEATURES

Our group's outcrop was heavily weathered and very dark colored in comparison to its surroundings. A medium-grained igneous texture composed of approximately equal amounts amphibole and plagioclase with a very minor amount of quartz leads us to call this a Hornblende-Diorite.

Outcrop Features:

- Heavily weathered and eroded into small cobble and boulder sized fragments
- ~50% Hornblende / ~50% Plagioclase
- Very minor amounts of quartz noted under 10x magnification
- Waxy veins of green mineralization
- Small spots of vitreous green minerals
- Moderately magnetic

Small (<0.5mm) metallic grains seen with USB magnification

Photographs showing phaneritic texture dominated by elongate hornblende crystals in a matrix of plagioclase with green deposits of epidote or olivine visible in close up.

OPTICAL MINERALOGY

Minerals identified in 30μm thin-sections agree well with hand sample observations. Minor amounts of pyroxene and a conspicuous lack of quartz grains was noted. Surprising quantities of epidote, chlorite, and other unidentified secondary minerals were seen along with possible olivine remnants.

Major Minerals:

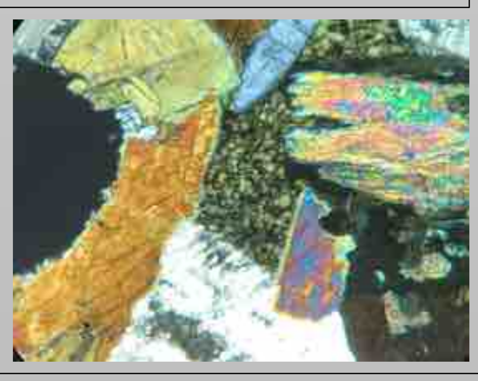
- Hornblende(~50%)
- Plagioclase Feldspar (~45%)
- Quartz (~<5%)

Minor Minerals:

- Pyroxenes
- Epidote
- Chlorite
- Olivine

Plane Polarized and Cross Polarized Light (PPL & XPL) photomicrographs showing Hornblende, Chlorite, Pyroxenes. Magnification 40x

1. Plagioclase 2. Hornblende 3. Perthitic Texture 4. Orthopyroxene? 5. Clinopyroxene? (XPL) Magnification: 40x.

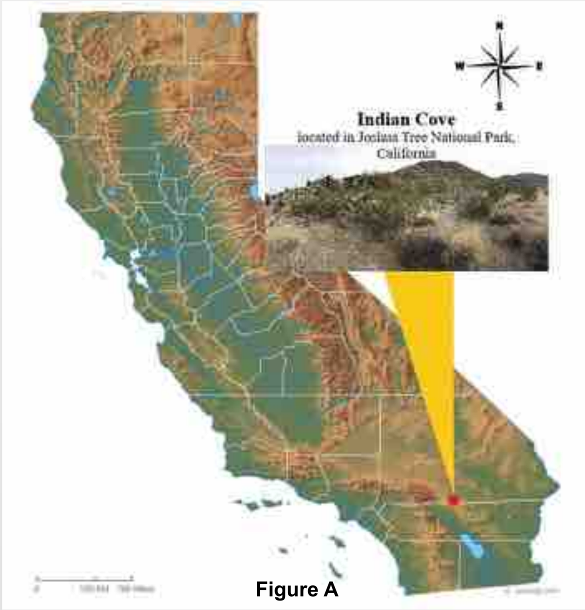


Epidote (high-birefringence) possibly altering to Chlorite(anomalous brown/green). (XPL) Magnification 40x.

Olivine crystallizing around prior mineral grains. Magnification 40x. (XPL)

GEOGRAPHIC CONTEXT

- Joshua Tree National Park is just East of San Andreas Fault
  - Hundreds of smaller faults run through the park, making it part of the larger transform fault zone
- ~1.7 kilometers northeast of Wonderland of Rocks and Indian Cove campground
- Hornblende diorite surrounded by different types of monzonites
- Contact in Wonderland of Rocks to the south between two strikingly different plutons



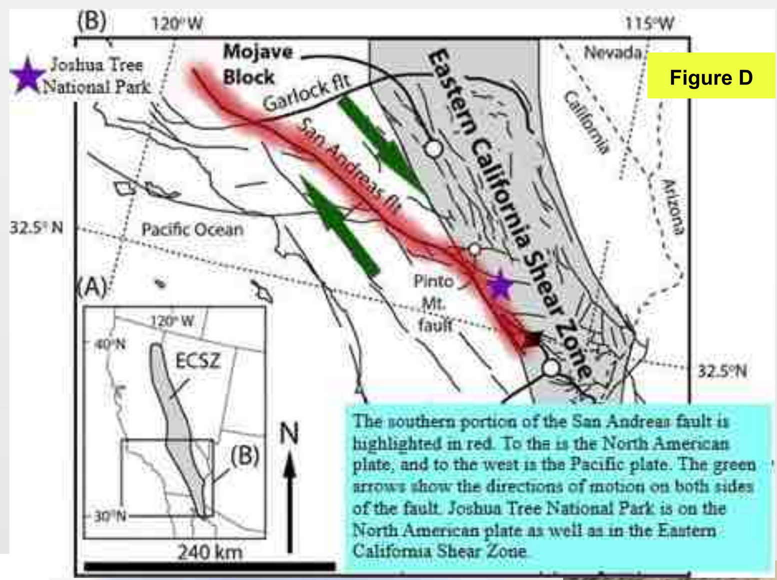


Figure D) Credit: Geoscienceworld. Figure E) Satellite image of area studied with outcrop labeled. (Credit: Google Earth). Figure F) Map of California showing lithology of parent materials. (Credit: University of California, Division of Agriculture, and Natural Resources).

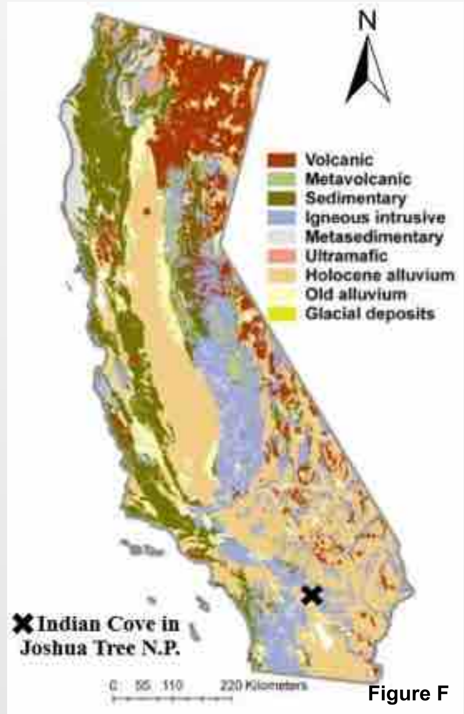
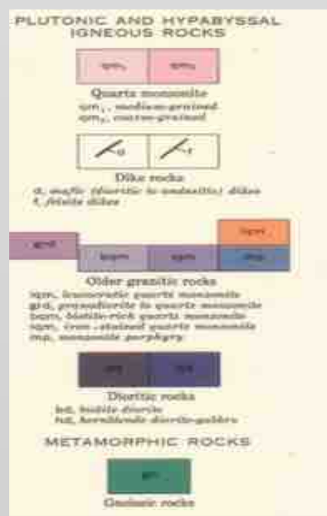
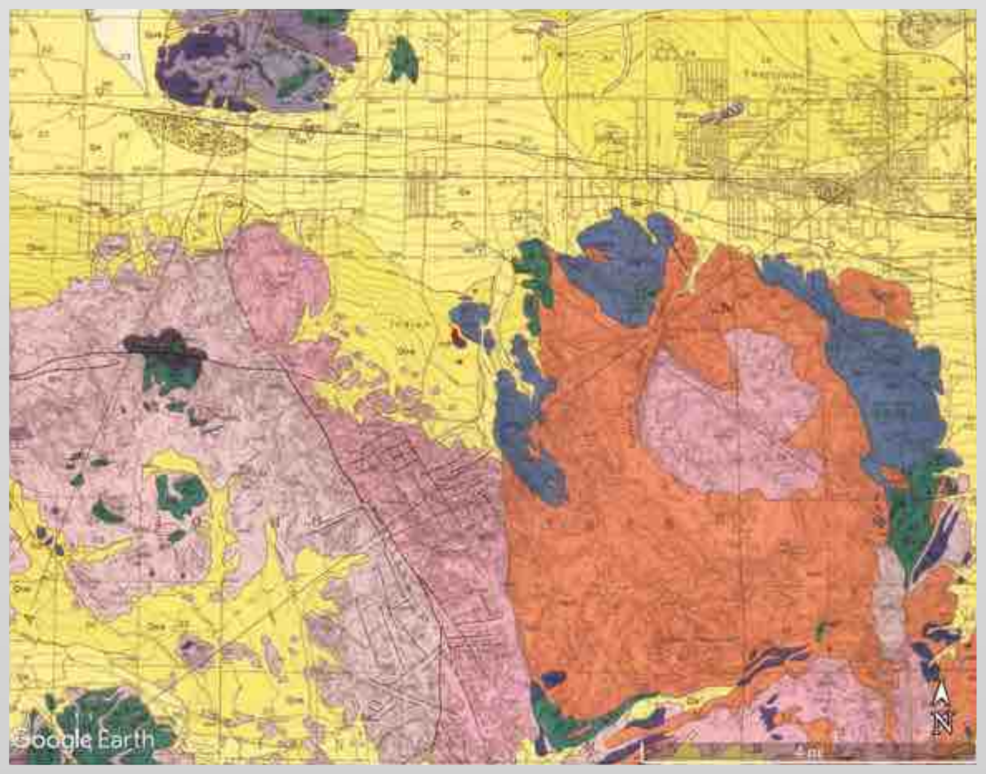


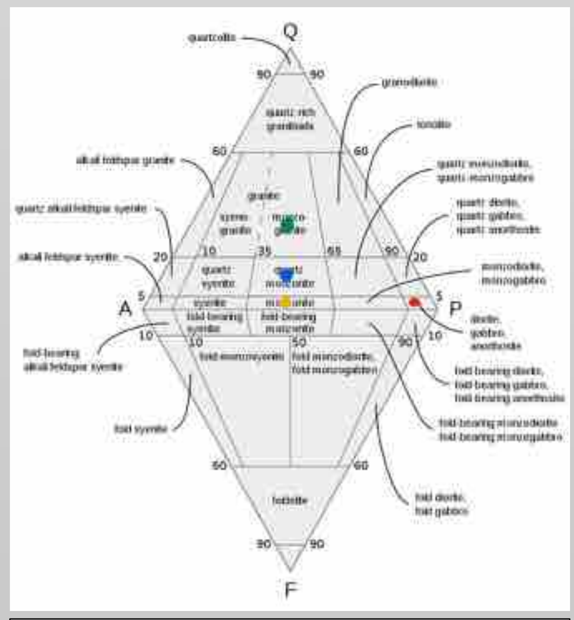
Figure A) Map of California, (credit: geology.com), showing the location of researched outcrop. Figure B) Study area. Photo faces ESE. Figure C) Panoramic photo showing study area and nearby contact zone in the Wonderland of Rocks. View faces South.

GEOLOGIC CONTEXT

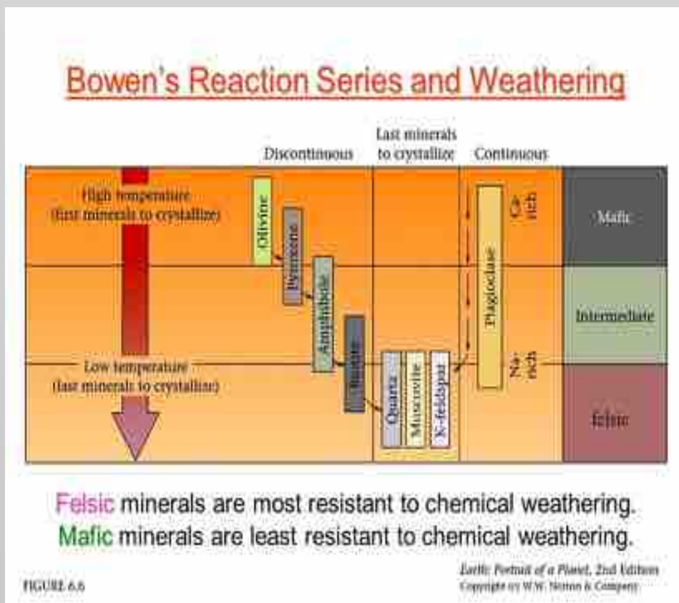
- Subduction zone moving closer to the coast during the Late Paleozoic and Mesozoic forming the continental margin magmatic arc running through Joshua Tree
- Outcrop is significantly different in composition compared to the other rocks in Joshua Tree (see QAP diagram).
- Rock composition contradicts crystallization per Bowen's reaction series.
- Additional small mafic outcrops nearby with similar composition but varying texture [2] indicate the possibility of multiple melts - however, extent unknown.





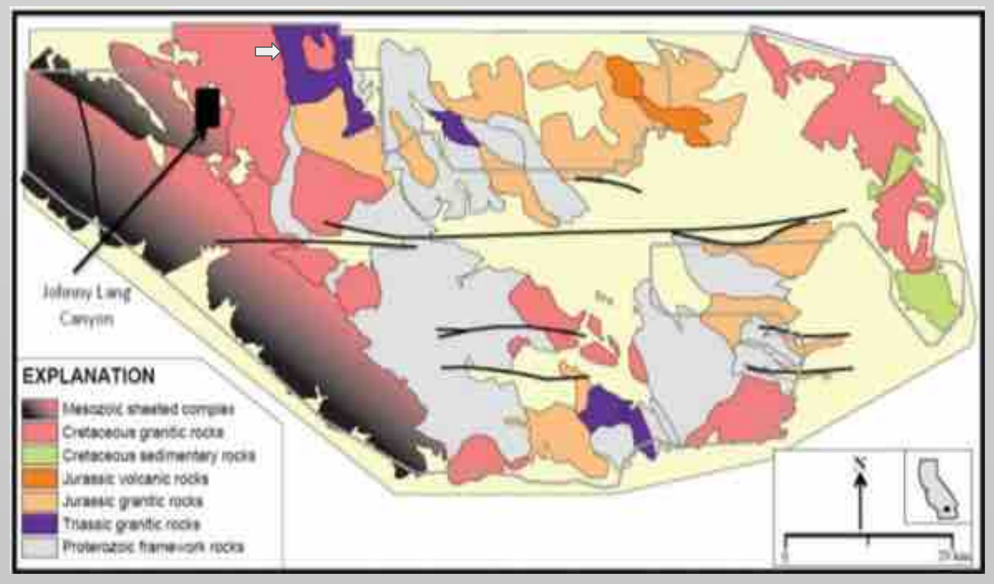


QAP diagram with study outcrop plotted in red. Nearby outcrops plotted in green, blue, and yellow. [3]



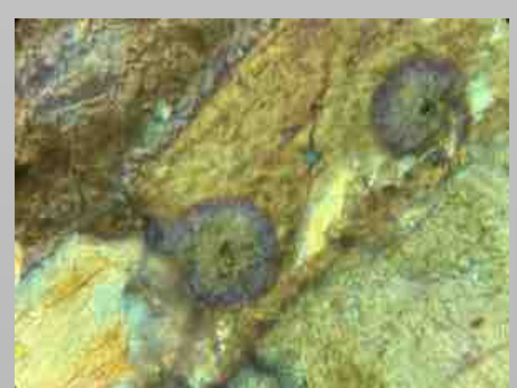
From Bowen's reaction series we can tell the lack of quartz and abundance of amphiboles and some pyroxene that this rock must have crystallized at higher temperatures.

Excerpt from USGS Geologic Map of Twentynine Palms Quadrangle [3]. The red arrow shows how small the outcrop is relative to the ones surrounding it. We also placed a white arrow where we believe the rocks are located on the figure showing relative age of granitic rocks on Joshua Tree [5]. Plutons from the Cretaceous were largely intruded at at shallow crustal levels. Given that there are hundreds of faults unmapped in Joshua Tree we suspect that there was some crustal block rotation that moved this pluton north-east. This is assumption was made by the mafic to felsic lithography if you follow the direction. Once the shallow block was rotated it was easily exposed by weathering.



FUTURE WORK TO BE DONE

- A more intensive petrographic examination including identifying any dateable mineral grains could be beneficial in establishing an age for the emplacement of this deposit.
  - Small mineral grains with radiation haloes were discovered, age could be determined through U-Pb if these are zircon.
- Additional sampling and investigation of other intermediate to mafic outcrops could help establish a sequence of events of emplacement.
- Working to positively identify additional fault traces in the region might aid in explaining the nearby gneissic outcrops and exhumation of our group's outcrop.



Small radiation haloes around unidentified mineral grains. XPL, 150x magnification.

USGS fault map of southern California. Approx. location of pre-Quaternary faults shown with black dashes.[10]

CONCLUSIONS

Although the exact ages of these rocks is unknown, this outcrop, also called the Gold Park Gabbro-Diorite appears to be older than many if not all of the other intrusive rocks [2].

The surprisingly mafic content of the rock implies that it may be the residue of a magma chamber, perhaps even the one that eventually produced the nearby monzogranite in Joshua Tree National Park's Wonderland of Rocks.

It is unknown the exact reason for this mafic outcrop being at this location but we hope to uncover the mystery as more research is conducted on the Twentynine Palms and Indian Cove area.

REFERENCES: 1. Geologic Formations - Joshua Tree National Park (U.S. National Park Service). 2. Igneous and metamorphic rocks of the western portion of Joshua Tree National Monument, Riverside and San Bernardino Counties, California : Rogers, John J. W. 3. Dibblee, T. W., Jr. "Geologic map of the Twentynine Palms quadrangle, San Bernardino and Riverside Counties, California." (1968). doi:10.3133/i561 4. Andrew P. Barth., J. Lawford Anderson., Carl E. Jacobson., Scott R. Paterson., Joseph L. Wooden.," Magmatism and tectonics in a tilted crustal section through a continental arc, eastern Transverse Ranges and southern Mojave Desert." The Geological Society of America. Field Guide 11 (2008). 18. Print. 5. David Horrell. "Unfolding The Tectonic History Of Joshua Tree National Park: A Structural And Petrologic Analysis Of The Johnny Lang Canyon Region."(2011) 20. Print. 6. Becky Oskin, Senior Writer. "Fault Lines: Facts About Cracks in the Earth." Live Science, 30 Nov. 2017, https://www.livescience.com/37052-types-of-faults.html. 7. Faults - Joshua Tree National Park (U.S. National Park Service). https://www.nps.gov/jotr/learn/nature/faults.htm. Accessed 27 Nov. 2018. 8. Ricketts, Jason W., et al. "Episodic Growth of the Chocolate Mountains Anticlinorium Recorded By the Neogene Bear Canyon Conglomerate, Southeastern California, U.S.A." Journal of Sedimentary Research, vol. 81, no. 12, GeoScienceWorld, Dec. 2011, pp. 859–73. 9. University of California, Division of Agriculture, and Natural Resources. Soils. http://rangelandarchive.ucdavis.edu/Annual_Rangeland_Handbook/Soils/. Accessed 30 Nov. 2018. 10. State of California. Fault Activity Map of California. Available at: http://maps.conservation.ca.gov/cgs/fam/.

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49 Palms Oasis Peraluminous Muscovite-Garnet Bearing Granodiorite

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Hand Sample Properties

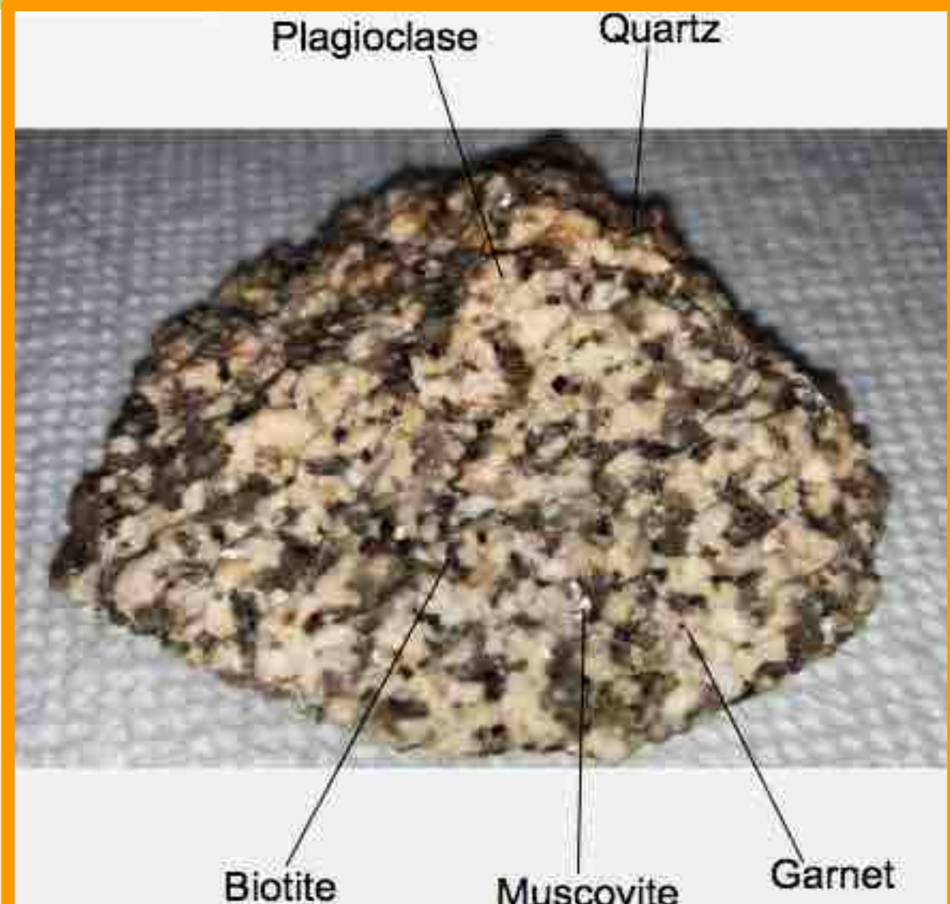


Fig 1.1 Hand sample of granodiorite harvested from 49 Palms Oasis boulders exhibiting the minerals Plag, Quartz, Biotite, Muscovite, and Garnet

Table 1.1 Initial Observations of Rock

Color	Whitish to Specks of Black to Grey to Tan to Greyish White
Minerals	Garnet (Spessartine or Almandine), Muscovite, Biotite, Plagioclase, Quartz, A little bit of Orthoclase
Abundance of Minerals	60% Plag, Quartz 25%, 15% in Akali
Grain Size	Medium grain equigranular.
Grain Shape	Equigranular
Fabric	None
Weathering	Exfoliation creating fractures that are parallel to the surface. Oxidized with visible crystals. Flooding.

Table 1.2 Initial Observations of Rock Minerals

	Formula	Luster	Color	Proportion	Crystal Habit	Cleavage
Muscovite	$KAl_2AlSi_3O_{10}(OH)_2$	Metallic	Grayish silver	2%	Platy	One plane of perfect cleavage
Garnet	$(Ca,Fe,Mg,Mn)_3Al_2Si_3O_{12}$	Vitreous	Reddish Brown	1%	Equant	None, it fractures sub-conchoidally
Biotite	$K(Fe,Mg)_3AlSi_3O_{10}(OH)_2$	Vitreous	Black	2%	Platy	One plane of perfect cleavage
K-spar	$KAlSi_3O_8$	Vitreous	Pale pink	15 %	Blocky	2 planes at 90 degrees
Quartz	SiO_2	Waxy	Greyish	20%	Equant	None, it fractures conchoidally
Plagioclase	$NaAlSi_3O_8$--$CaAl_2Si_2O_8$	Dull	Chalky Milky	60%	Equant	90 degrees

Table 1.3 Mineral Test Performed

	Streak	Hardness	Effervescence	Magnetism
Muscovite	White	2.5	No	No
Garnet	White	6.5	No	No
Biotite	White/Grey	3	No	No
K-feldspar	White	6	No	No
Quartz	Colorless/White	7	No	No
Plagioclase	White	6	Yes	No

Optical Properties

Table 2.1 Plane Polarized Light Optical Properties

	Relief	Refractive Index	Cleavage	An/Isotropic	Pleochroism Color
Muscovite	Low to Moderate	n_α = 1.552 - 1.576, n_β = 1.582 - 1.615, n_γ = 1.587 - 1.618	perfect-1 plane	Anisotropic	No
Garnet	Moderate to high	1.789-1.820	Fractures	Isotropic	No
Biotite	Low to Moderate	1.523-1.696	Perfect 1 plane	Anisotropic	Yes
K-feldspar	Low	n_α = 1.518 - 1.520, n_β = 1.522 - 1.524, n_γ = 1.522 - 1.525	2 planes @ 90°	Anisotropic	No
Quartz	Little to no relief	1.544-1.553	Fractures	Anisotropic	No
Plagioclase	Little to no relief	(Albite)1.527-1.577, 1.531-1.585, (Anorthite)1.534-1.590	2 planes @ 90°	Anisotropic	No

Thin Sections in Plane Polarized Light

Plagioclase, K-Feldspar, and Quartz in PPL at 50x

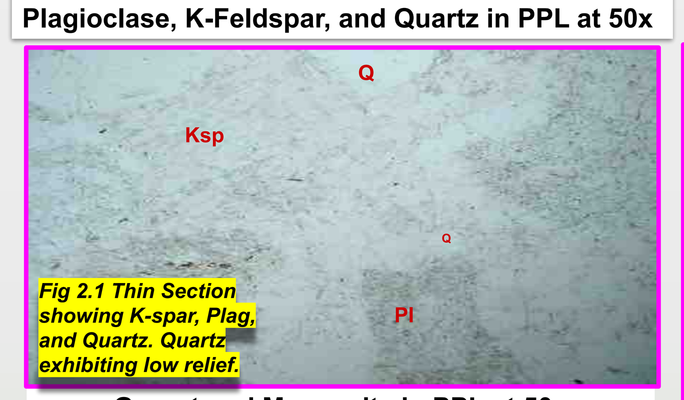


Fig 2.1 Thin Section showing K-spar, Plag, and Quartz. Quartz exhibiting low relief.

Garnet and Muscovite in PPL at 50x

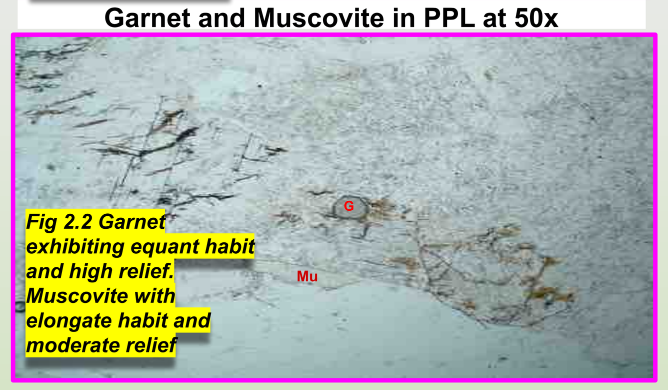


Fig 2.2 Garnet exhibiting equant habit and high relief. Muscovite with elongate habit and moderate relief

Biotite, Muscovite, and Garnet in PPL at 50x

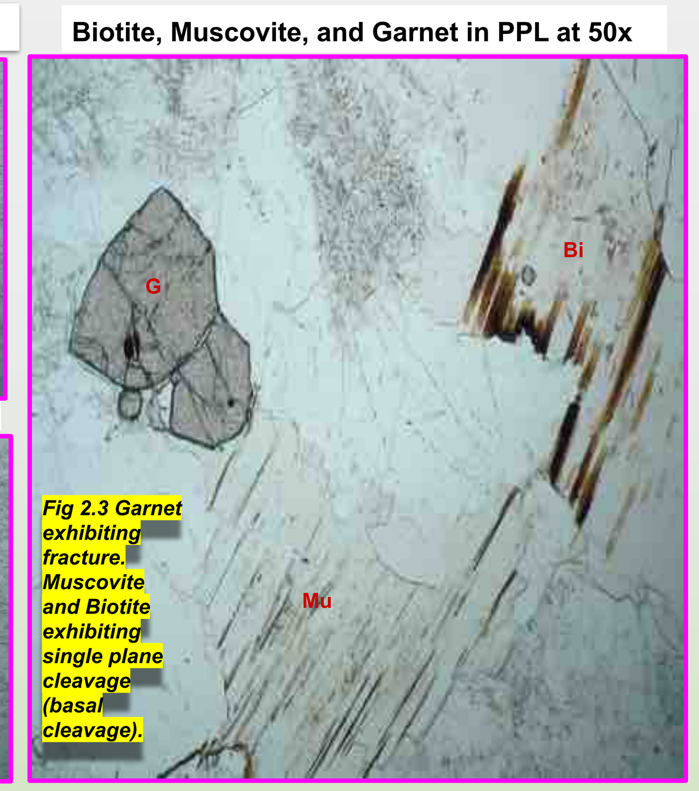


Fig 2.3 Garnet exhibiting fracture. Muscovite and Biotite exhibiting single plane cleavage (basal cleavage).

Table 2.2 Cross Polarized Light Optical Properties

	Interference Colors	Twinning	Birefringence	Order	An/Isotropic
Muscovite	Neon green, yellow, blue	none	0.036 - 0.049	3rd Order	Anisotropic
Garnet	Extinct	none	-	-	Isotropic
Biotite	Brown	none	0.03-0.07	3rd Order	Anisotropic
K-Feldspar	Grey	Tartan	δ = 0.004 - 0.005	1st Order	Anisotropic
Quartz	Grey,white	none	.009	1st Order	Anisotropic
Plagioclase	Grey,white, yellow	Albite	.007-.013	1st Order	Anisotropic

Thin Sections in Cross Polarized Light

Plagioclase, K-Feldspar (Microcline), and Quartz in XPL at 50x

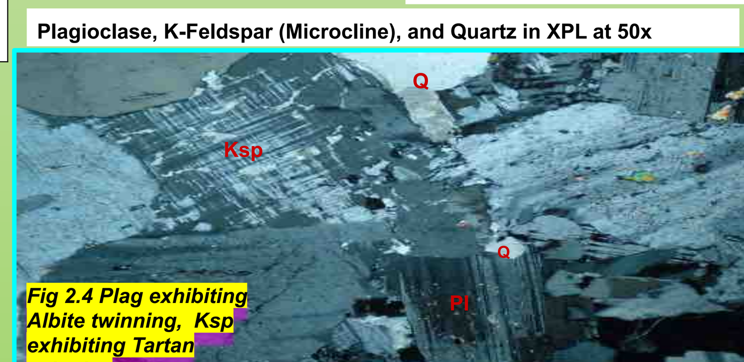


Fig 2.4 Plag exhibiting Albite twinning, Ksp exhibiting Tartan twinning

Garnet and Muscovite in XPL at 50x

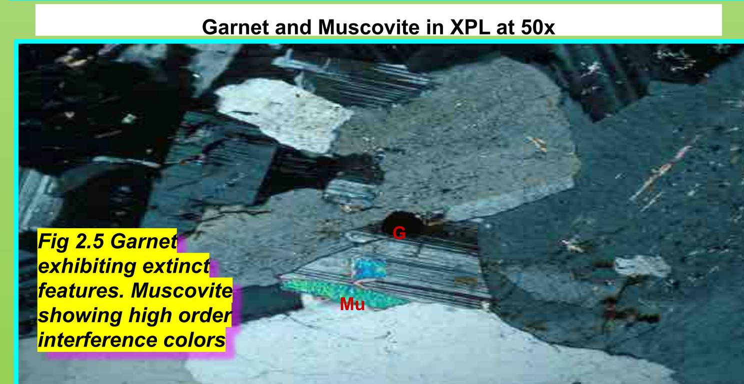


Fig 2.5 Garnet exhibiting extinct features. Muscovite showing high order interference colors

Biotite, Muscovite, and Garnet in XPL at 50x

Fig 2.6 Quartz, Muscovite, and Biotite. Biotite exhibiting bacon like appearance.

Outcrop Environment

Aerial view of Trail

Fig 3.1 Starting point of Oasis Trail

Location of the Outcrop

- About two miles South from Highway 62 trailhead
- Vertical Exaggeration of 2,725 ft - 3,070 ft over a 1.5 mile distance.
- Just pass the Fortynine Palms Canyon

Aerial view of Trail

Fig 3.2 Ending Point of Oasis Trail leading to 49 Palms Oasis

Features of the Outcrop

Nearby Spring]

Fig 3.3 Currently dry spring, but frequently visited by nearby animals in the area

Palm Trees

Fig 3.4 View from afar when walking towards Oasis on Oasis trail

Valley (facing away from the Palm trees)

Fig 3.5 Valley outlook of 29 palms. Frequent winds pass through the valley

Large Boulders of Granodiorite

Fig 3.6 Left side of Boulder with Sr Splotches and Frost Wedging

Fig 3.7 Right Side of Boulder

An Oasis for Nearby Animals

Fig 3.8

Fig 3.9

Fig 3.10

Fig 3.8 Burrows and possible Sheep horn abrasions
Fig 3.9 Additional burrows the size of a medium rock
Fig 3.10 Desert Bighorn Sheep is a frequent customer of the Oasis spring.

Erosional Patterns

Exfoliation

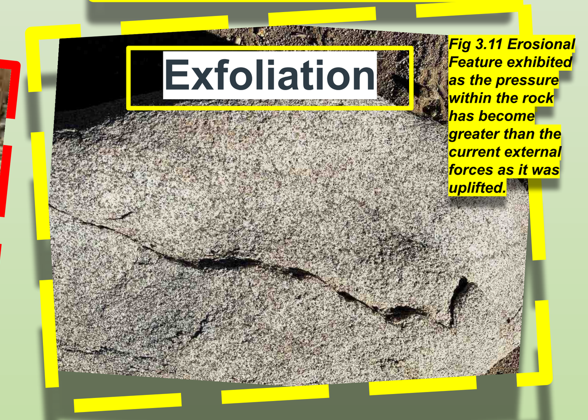


Fig 3.11 Erosional Feature exhibited as the pressure within the rock has become greater than the current external forces as it was uplifted.

Frost Wedging

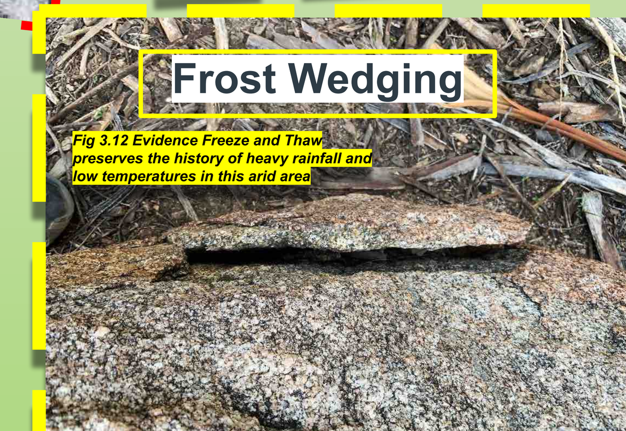


Fig 3.12 Evidence Freeze and Thaw preserves the history of heavy rainfall and low temperatures in this arid area

Dike Intrusions

Fig 3.13 Light colored Aplite dike intrusion

Geological Time Scale of Area:

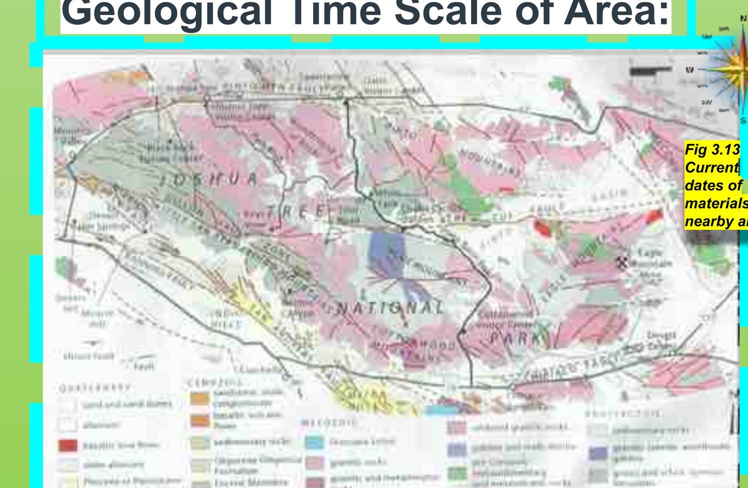


Fig 3.13 Current dates of materials of nearby area.

Theoretical Laws Applied

Fig 4.1 Bowen's Reaction Series: Identified as a Felsic Igneous Rock

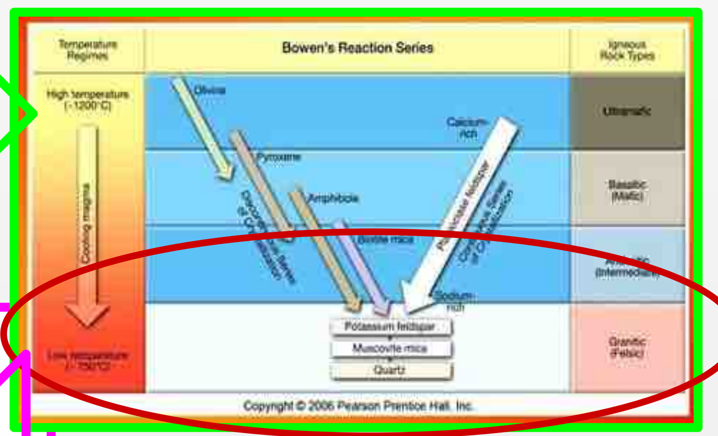


Fig 4.2 Feldspar Ternary Diagram: Identified the Plagioclase Feldspar as Albite

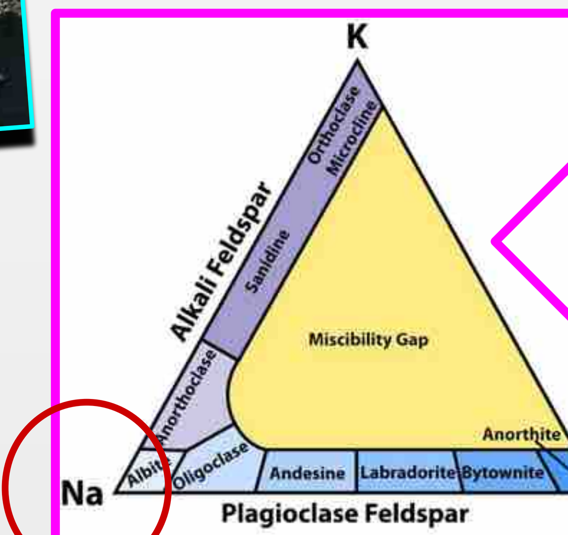
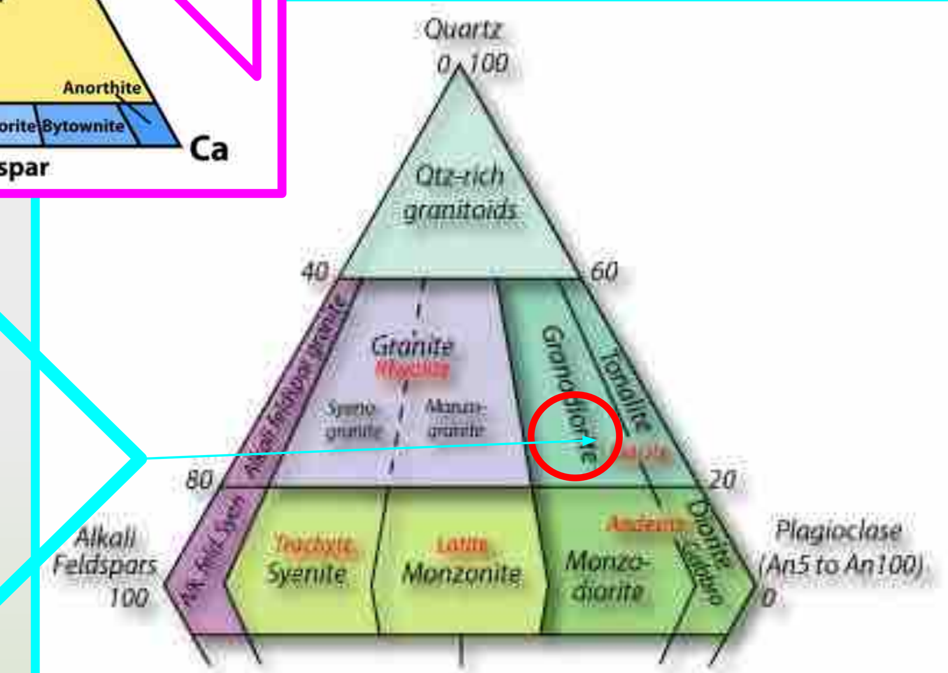


Fig 4.3 QAP Diagram: Identified as a Granodiorite with a composition of

- 60% Plag
- 25% Quartz
- 15% Akali



Significance of this Granodiorite

This granodiorite is dated back to be from the Late Cretaceous between 85-90 million years ago (*J.S.Miller and A.F. Glazner, 1996*). It was the youngest to crystalize out all three rocks encountered in the 49 Palms trail. The outcrop is defined as a **garnet-bearing two-mica peraluminous granodiorite**, meaning it contains **muscovite** and **biotite** and has greater proportions of **Al_2O_3** than **CaO + NaO + K_2O** (*D.B. Clarke, 1981*). This is an **S-type** granite where the muscovite appears to be primary due to its coarse and unaltered features (*C.F. Miller and L.J. Bradfish, 1980*).

Types of Granites

S-type	I-type
Sedimentary source rock (metapelitic material melted)	Igneous source rock (Igneous material melted)
Strongly peraluminous	not peraluminous, contains hornblende
Associated with regional metamorphism	Rarely associated with regional metamorphism
Low Na_2O (<3.2%)	Higher Na_2O (>3.2%)

Based on I- and S-type classification by (Chappell and White, 1992)

- **The region was a tectonically youthful area that included a lot of volcanism due to subduction zones in the Late Cretaceous.**
- **This rock originated from a subduction zones, which for an S-TYPE granite is highly unusual.**
- **The variable isotopic composition (high Sr, Nd and O) of rock suggests a partial melting of a heterogeneous crustal source.**(*J.S. Miller and A.F. Glazner, 1996*)
- **"Their composition show that their source was distinctly different from that of Muscovite granites"** (*C.F.Miller and LJ Bradfish, 1980*)
- **This rock is found near its source, which is not common for granites** (*A.J.R. White and B.W. Chappell, 1986*)
- **Peraluminous rocks seem to be common on continental arcs all around the world. Ex: Lachlan Fold Belt (LFB) in Eastern Australia, South China, and Central Africa**

REFERENCES

Clarke, D. B. "The Mineralogy of Peraluminous Granites: A Review." Canadian Mineralogist, vol. 19, Oct. 1981, pp. 3–17.

Miller, Calvin F., and Larry J. Bradfish. "An Inner Cordilleran Belt of Muscovite-Bearing Plutons." Geology, vol. 8, no. 9, Sept. 1980, pp. 412–416., doi:10.1130/0091-7613(1980)8<412:aicbom>2.0.co;2.

Miller, Jonathan S., et al. "Muscovite-Garnet Granites in the Mojave Desert: Relation to Crustal Structure of the Cretaceous Arc." Geology, vol. 24, no. 4, Apr. 1996, pp. 335–338., doi:10.1130/0091-7613(1996)024<0335:mggitm>2.3.co;2.

White, A.j.r., et al. "S-Type Granites and Their Probable Absence in Southwestern North America." Geology, vol. 14, no. 2, Feb. 1986, pp. 115–118., doi:10.1130/0091-7613(1986)14<115:sgatpa>2.0.co;2.

Montecito Debris Flow

San Ysidro Creek

490-trip

Alex Thoben, Leticia Medina, Clarissa Jones, and Jennifer Bautista

Introduction

Background:

- The San Ysidro Creek is located in Montecito, Santa Barbara County, California.
- The creek originates in the foothills of the Santa Ynez Mountains and drains a 2,621-acre watershed capable of producing 3500 cfs during a 100-year return period rain event.

History:

The area was part of a land grant in 1769 by the Charles III of Spain. Home of the famous San Ysidro Ranch.

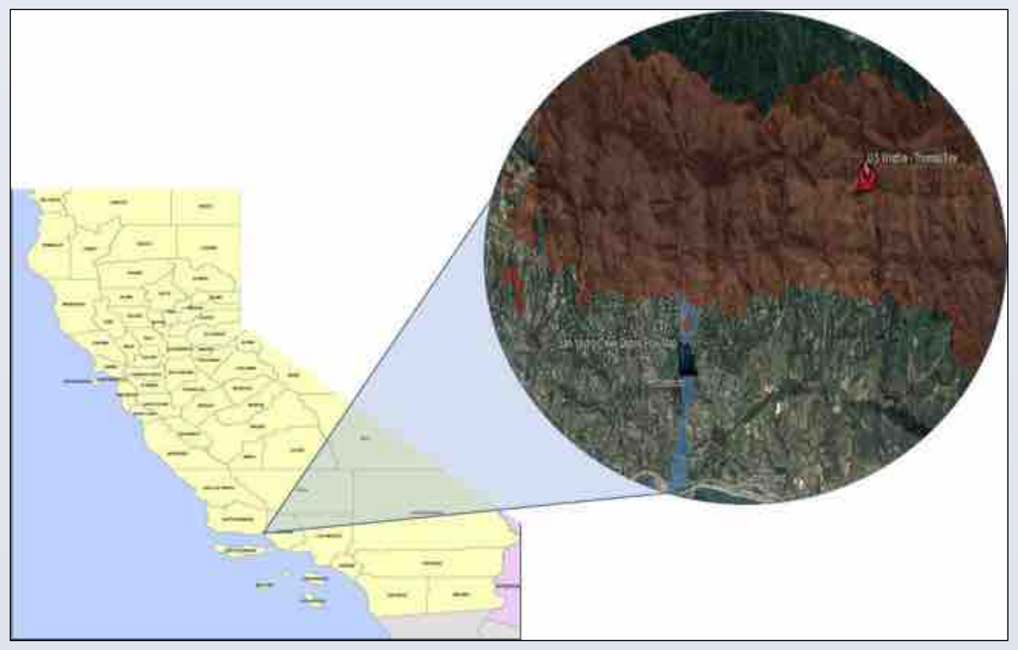


Figure 1. San Ysidro Creek Index Map

Debris Flow Characteristics

Figure 2. Debris Flow Assessment

- Moving mass with large materials
- Debris Flow velocity of 27 mph
- Creek was scoured 10 to 15 feet deeper than its original depth by the flow.
- Potential debris-flow volume is calculated with the equation:

$$\ln(v) = 4.22 + (0.13 \times \sqrt{\text{Elev range}}) + (0.36 \times \ln(HM_{km})) + (0.39 \times \sqrt{i15})$$

Affected Area

Figure 3. San Ysidro Creek Debris Flow and Thomas Fire

Precipitation and San Ysidro Creek discharge

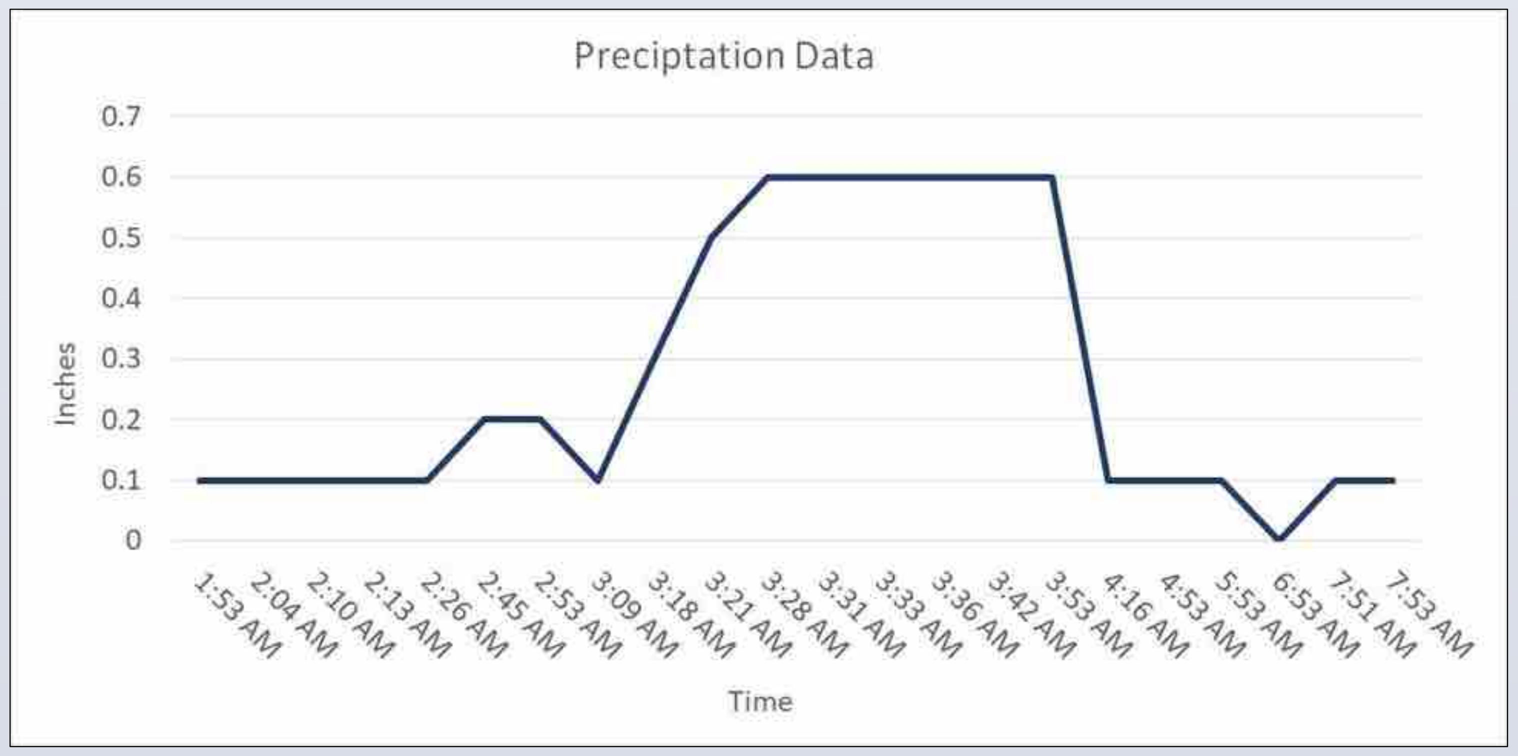


Figure 4. Precipitation from a weather station located on the creek, the night of January 9th

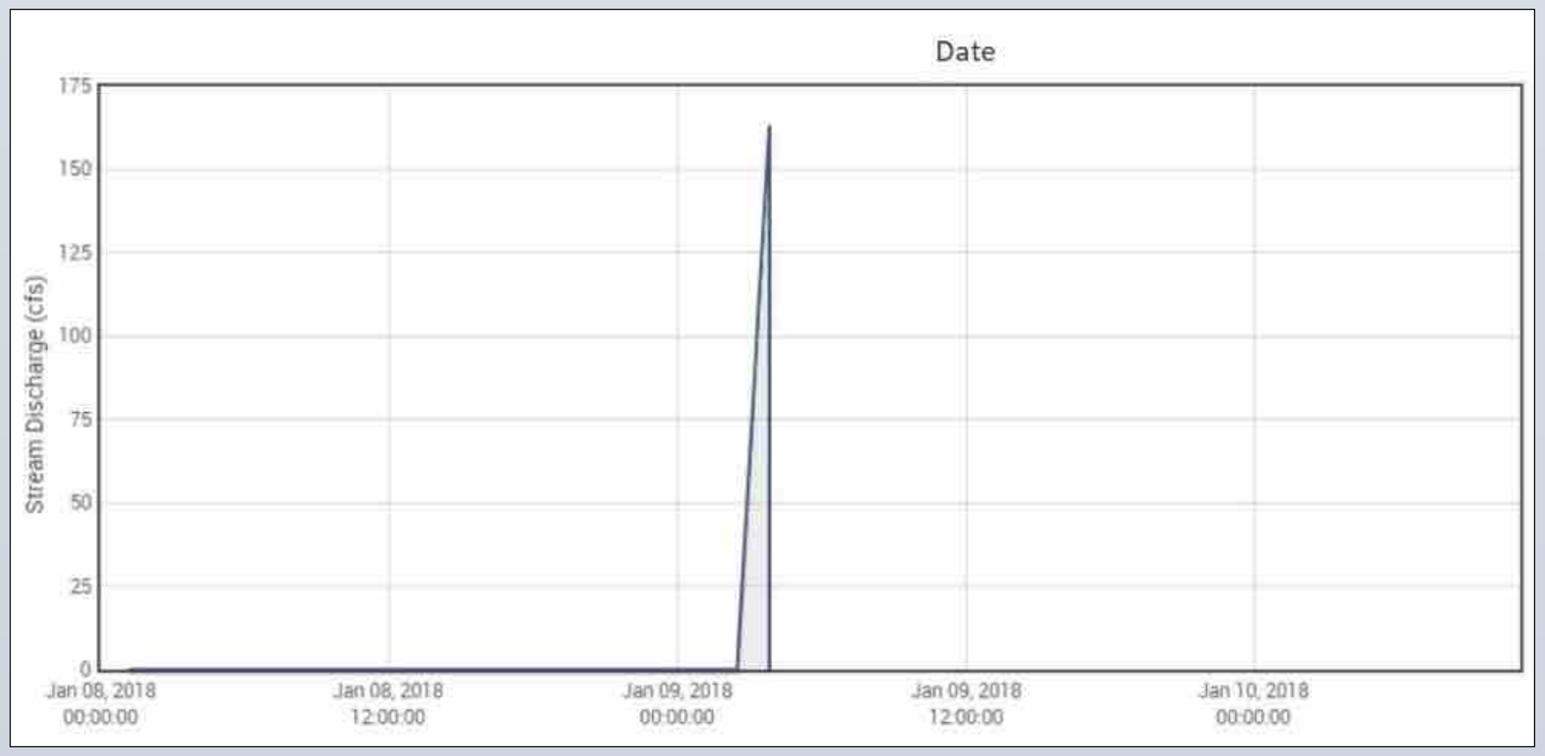


Figure 5. Stream gauge data from a nearby creek on the night of January 9th

Affected Homes

Figure 6. A residential area along San Ysidro Creek on Tuesday.

Area	Destroyed	Damaged	Intact
North of E. Valley Road	29	9	10
E. Valley Road - 101 Freeway	28	22	0
101 Freeway - Ocean	0	3	8

Table 1. Destroyed, damaged, and intact homes.

Prevention Measures

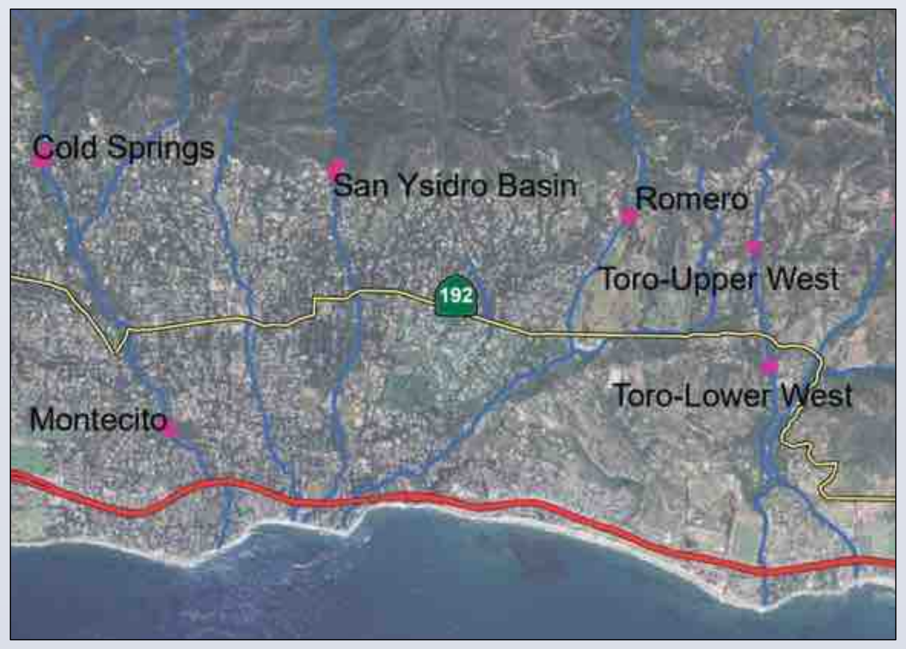


Figure 7. San Ysidro Creek Debris Basin in the Santa Barbara County

San Ysidro Debris Basin:

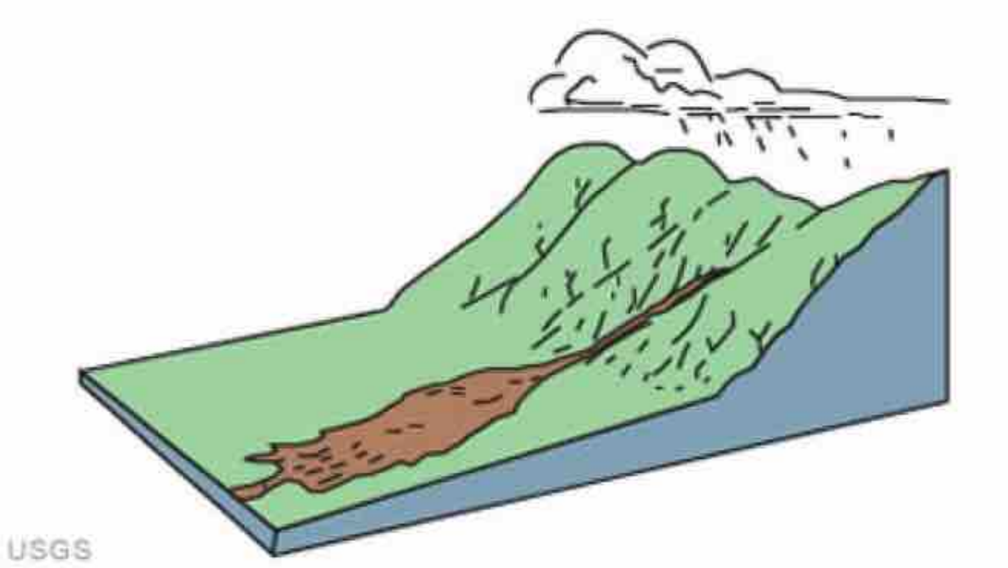
- Built in 1964 by Army Corps of Engineers.
- Originally designed for 11,000 yd^3 of flood debris.
- By 2005 capacity lowered to 7,945 yd^3.
- Maintained on an annual basis after construction until 1987.
- Maintained on an as-needed basis from 1987 and 1994.
- Desilting projects occured six times from 1969 to 2005.
- Scheduled to be destroyed by 2019 to implement a critical habitat for endangered steelhead.

https://www.countyofsb.org/uploadedFiles/pwd/Content/Water/Environmental/Updated%20Debris%20Basin%20Plan_Final.pdf
https://www.washingtonpost.com/graphics/2018/national/montecito-before-after/?noredirect=on&utm_term=.88c58b6143b9
https://www.countyofsb.org/uploadedFiles/pwd/Content/Water/Environmental/Updated%20Debris%20Basin%20Plan_Final.pdf
https://www.independent.com/news/2018/jun/12/montecitos-history-violence/
http://www.latimes.com/local/california/la-me-san-ysidro-damage-20180112-htmlstory.html

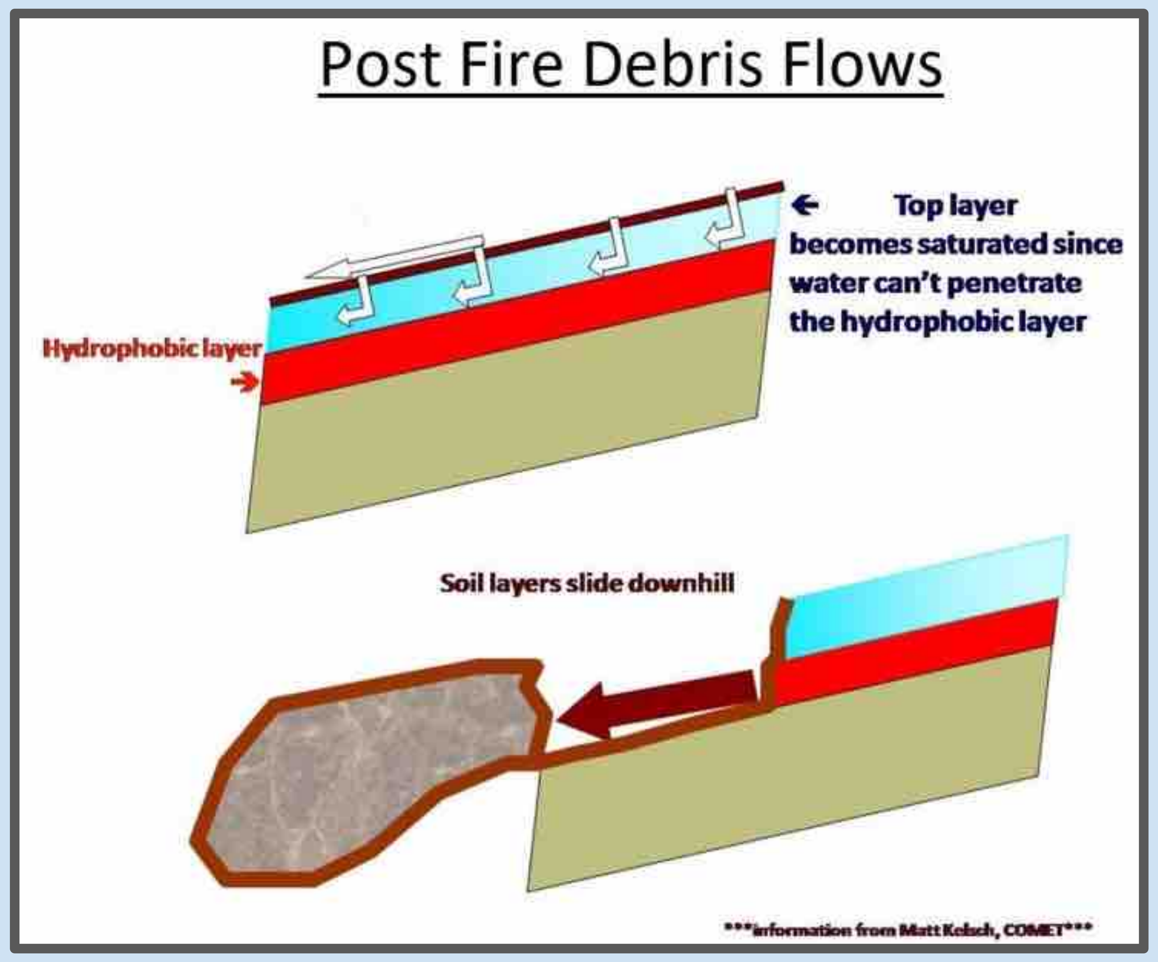
“Water” the Causes of the Montecito Debris Flows?

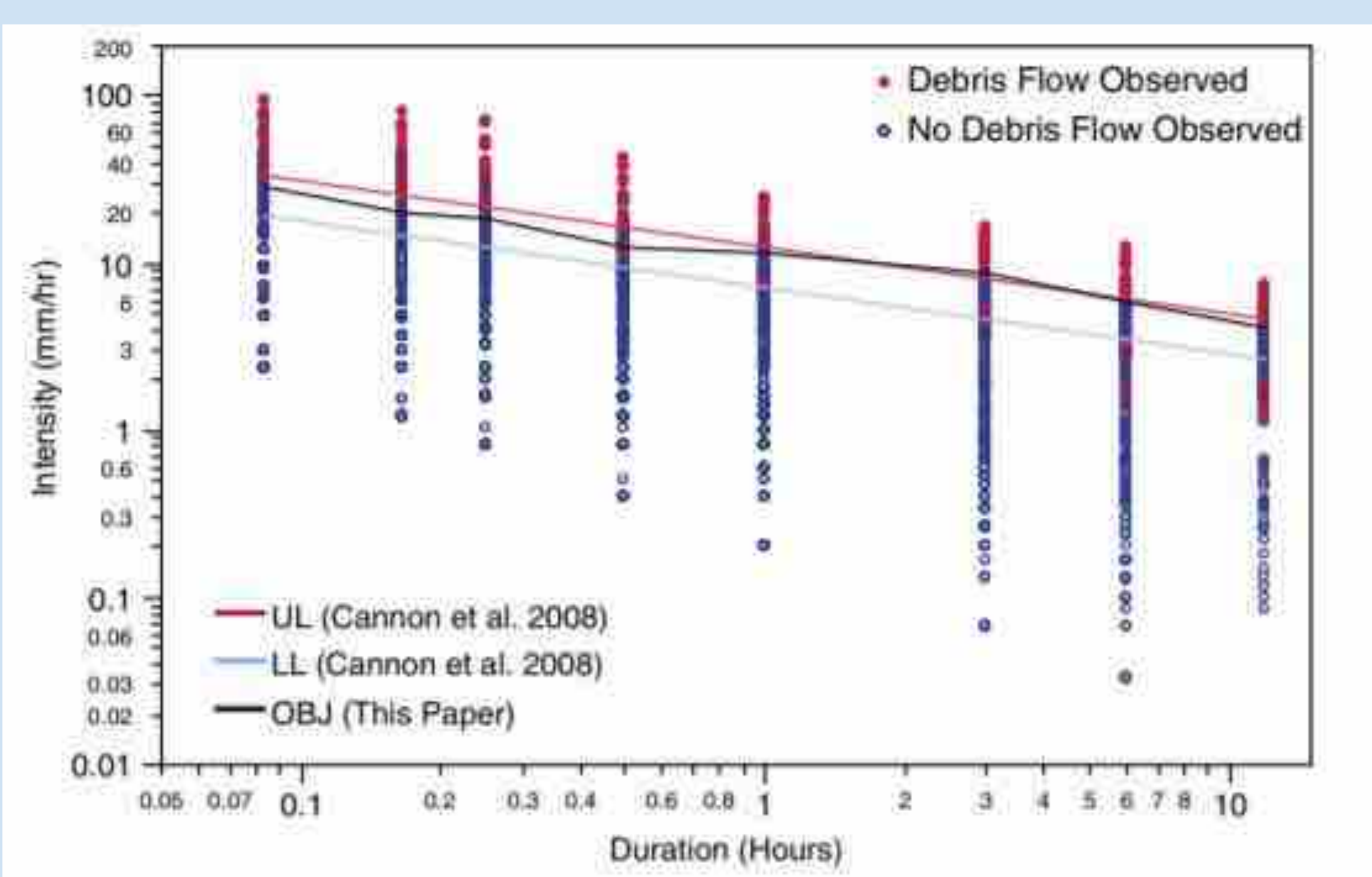
490-Capstone

Debris Flows



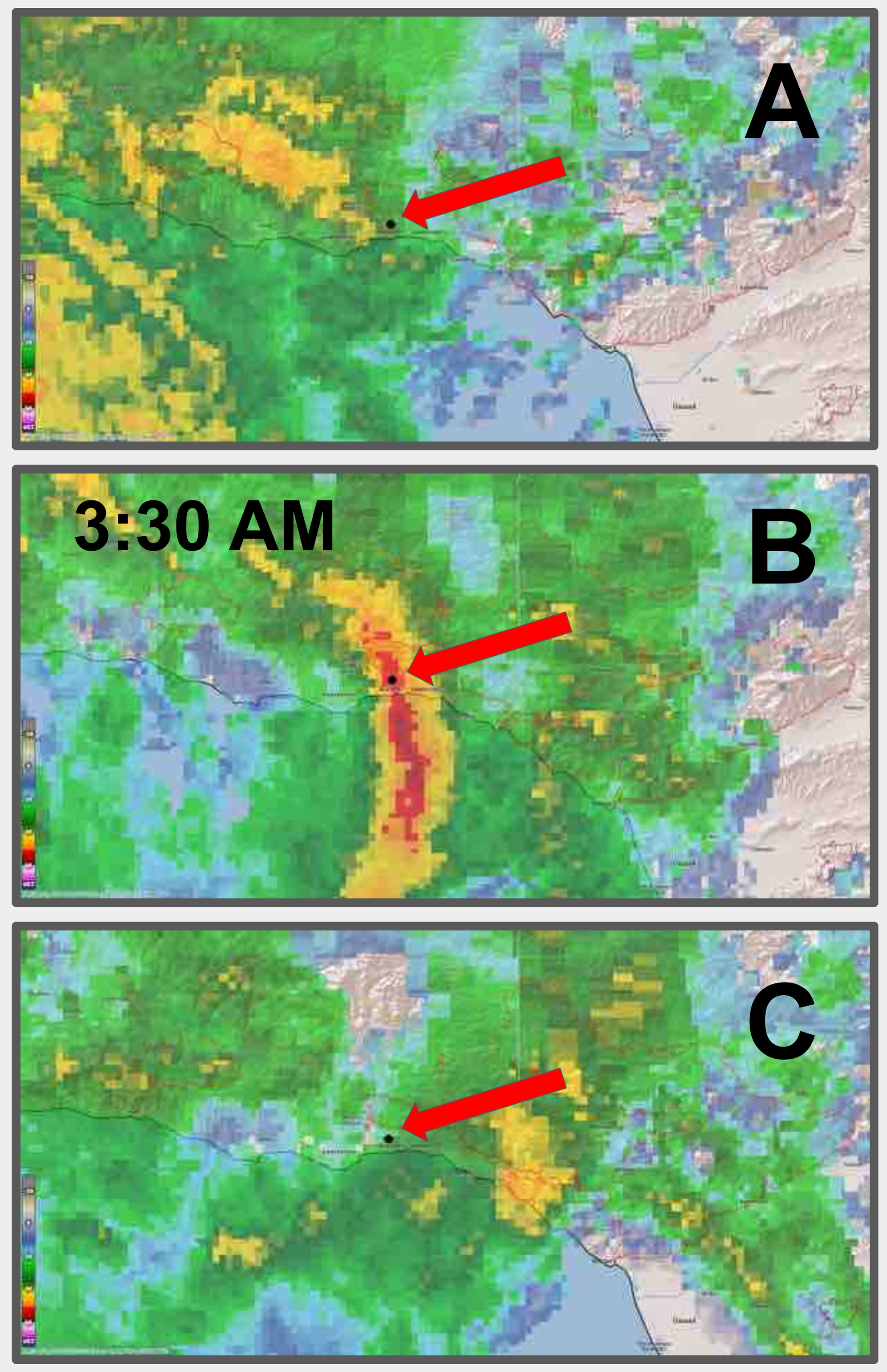
Textbook Recipe for a Debris Flow:
1. Steep slope
2. Abundant supply of loose debris
3. Abundant source of moisture
4. Sparse vegetation





An intensity- rainfall threshold chart. 3 different models (upper limit, lower limit, and a median objective) show what rainfall intensities trigger debris flows.(2)

Weather

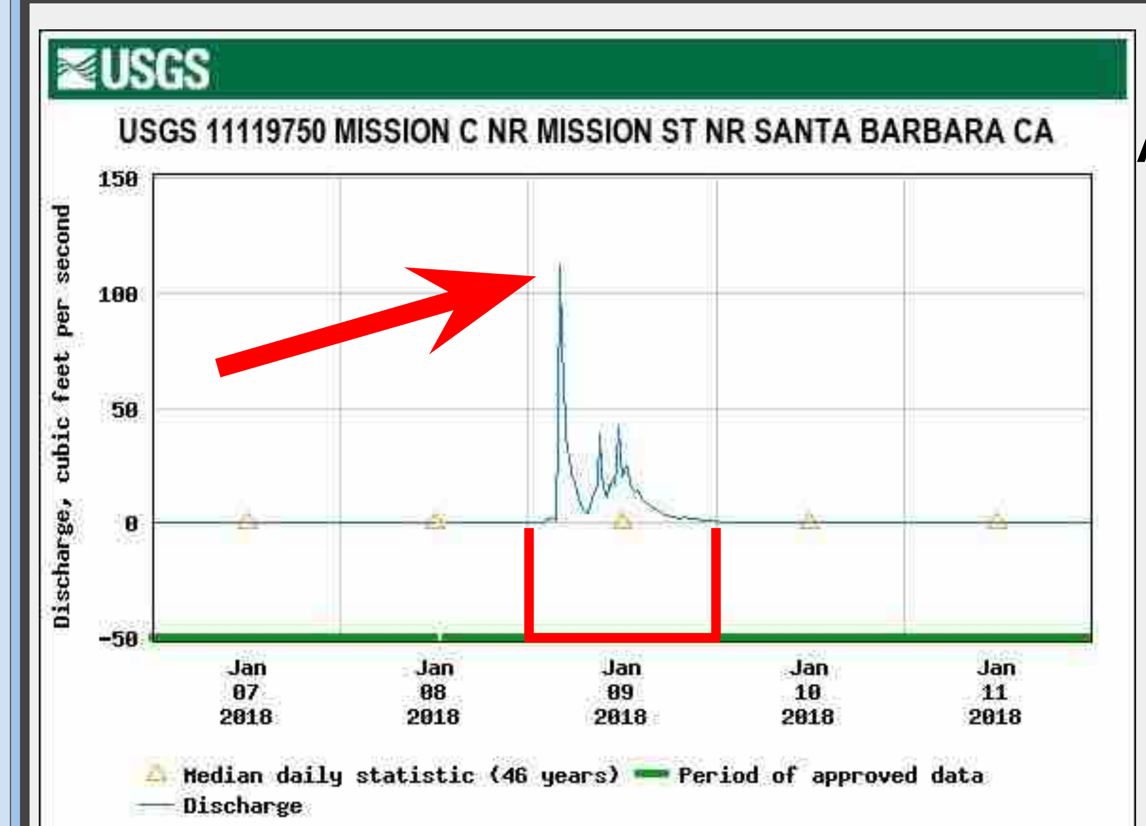


A.1.5 hours before debris flows

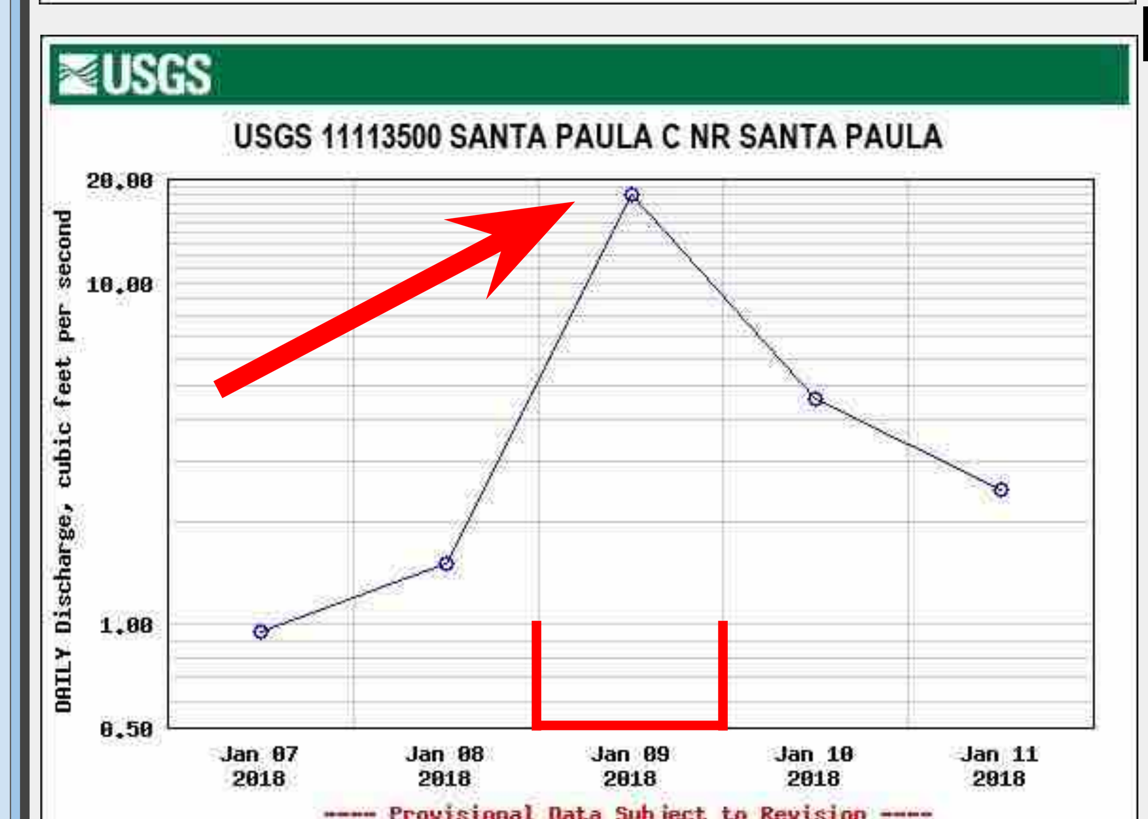
B.Peak intensity over Montecito, debris flow initiation

C. 45 minutes after debris flow initiation(1)

Stream gauges

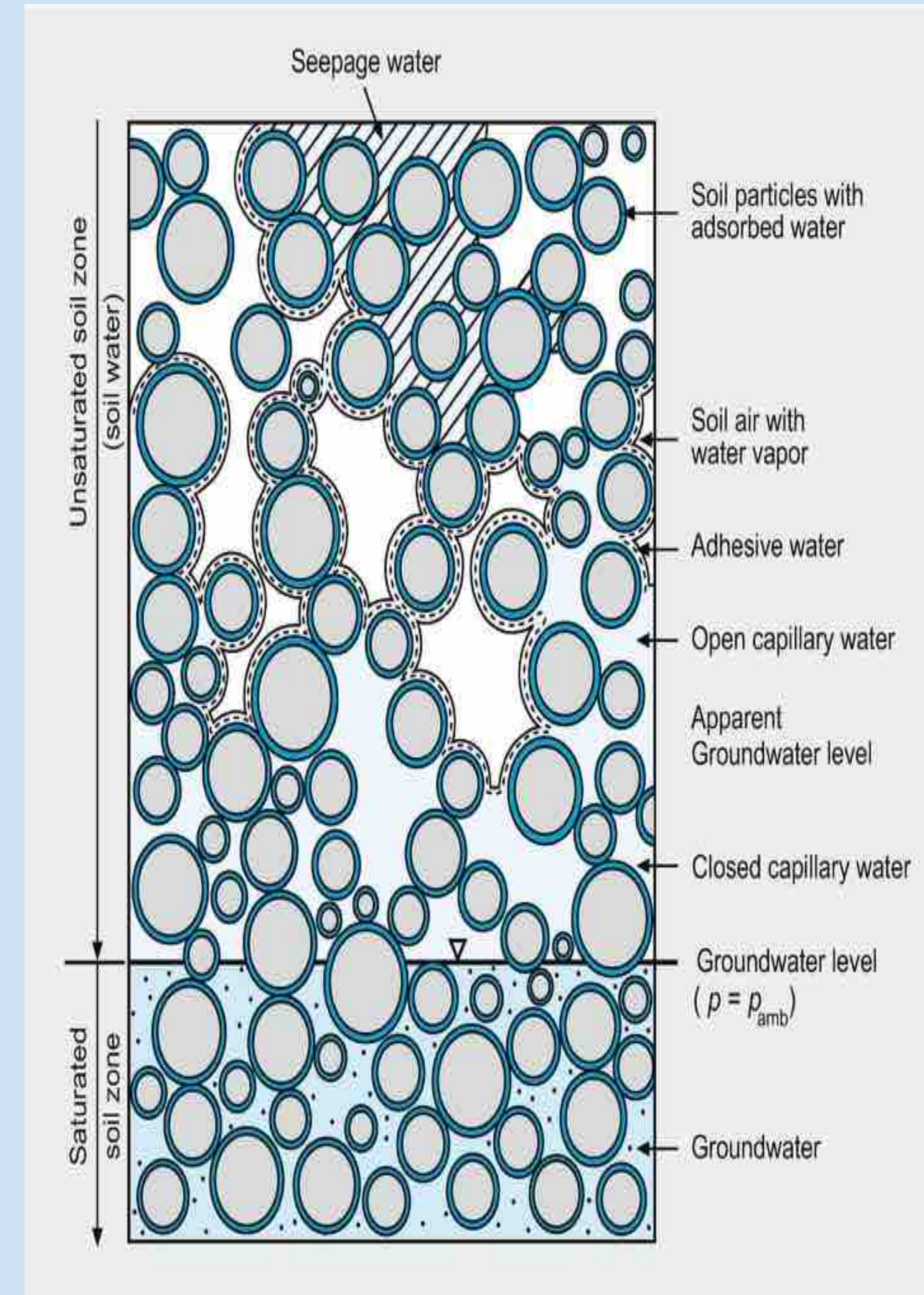


A. Stream gauge station near Montecito <u>Peak</u> ~120 cfs



B. Stream gauge station on the East side of Ojai <u>Peak</u> ~18 cfs

Soil characteristics



Water infiltration occurs via pore space, which is a function of texture and vegetation.

Available Water Capacity by Soil Texture

Textural Class	Available Water Capacity (Inches/Foot of Depth)
Coarse sand	0.25–0.75
Fine sand	0.75–1.00
Loamy sand	1.10–1.20
Sandy loam	1.25–1.40
Fine sandy loam	1.50–2.00
Silt loam	2.00–2.50
Silty clay loam	1.80–2.00
Silty clay	1.50–1.70
Clay	1.20–1.50

Texture determines how much water a soil can hold. Anything above that leads to flooding or in this case, a mud flow.

Citations: (1)Nina Oakley at Desert Research Institute and USGS Landslide Hazards Program (2)Staley, D.M., Kean, J.W., Cannon, S.H., Schmidt, K.M., and Laber, J.L., 2012, Objective definition of rainfall intensity–duration thresholds for the initiation of post-fire debris flows in southern California: Landslides, v. 10, p. 547–562, doi: 10.1007/s10346-012-0341-9.