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RESEARCH REPORT

The Cerutti Mastodon Site Reinterpreted with Reference to Freeway Construction Plans and Methods*

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ABSTRACT
The Cerutti Mastodon (CM) site has been claimed as evidence for human presence in North America 130,000 years ago. Damage to mastodon bones at an active construction site was attributed to ancient human activity. Damage by modern construction equipment was not cited as a possible cause. Through reference to a freeway right-of-way map and construction plans, contemporary road building practices, and work site photographs available on the Internet, this paper concludes that freeway construction was responsible for the damage.

KEYWORDS
Cerutti Mastodon; California State Route 54; alternative interpretation; bone damage; freeway construction

1. Note on sources

This paper cites sources beyond the necessary publications that presented the original work (Holen et al. 2017), and the challenging and supporting papers it inspired. It uses construction plans and a right-of-way map personally obtained from the San Diego Caltrans district 11 headquarters office, and information from internet websites. The internet citations are of two types: civil engineering equipment and construction specifications, as well as Cerutti Mastodon (CM) site photographs made by the San Diego Natural History Museum. The photographs were apparently released as part of the "press kit" offered on the date of the announcement of the *Nature* letter, and at the time of this writing were no longer available as downloads of said "press kit" from the museum's website. The references offered as photograph sources are cited for that purpose only. Most are popular web-based scientific news publications. The authorship of articles is sometimes not given. Since websites are ephemeral in nature, the dates they were observed are given. They may not still be available.

For reasons of clarity, this paper uses the measurement units that were specified in original sources: feet in reference to the construction plan, and meters in reference to the CM site excavation.

2. The site location and topography

The Cerutti Mastodon site is in San Diego County, California, abutting the northerly right-of-way line of State Route 54 between stations 230 + 00 and 230 + 50 (Deméré, Cerutti, and Majors 1995, 22), east of the Reo Drive over crossing. Before construction, the area was a hilly ridge paralleling the new freeway. At about 350 feet east of the CM site the ridge blended with the local topography (State of California, Department of Transportation n.d.a). At station 230 + 00 the site was covered by about 9 feet (State of California, Department of Transportation n.d.c) of sediments generally described as "unnamed Pleistocene stream deposits" (Deméré, Cerutti, and Majors 1995, 1) (Figure 1).

3. Construction plan and methods

The freeway construction plan calls for grading the area of the CM site to form a 10-foot-wide access way/buffer zone along the northern right-of-way line, and a sound berm to the south of that (State of California, Department of Transportation n.d.b). Grading is the action of sculpting the earth surface in the project zone, as one would in the clay sculpting of a statue; removing material from one point to another to conform to the planed surface configuration, termed "grade." The sound berm is an embankment between the residential tract to the north, and the freeway. It is designed to shield those homes from traffic noise. A structural cross section of the sound berm at station 230 + 00 joins the access way 10 feet south of the right-of-way line at plan elevation 151.00 feet, then rises toward the freeway at a slope ratio of 2 feet horizontally to 1 feet vertically (2:1) to elevation 158.00 feet, then goes a variable distance horizontally, before plunging at a 2:1 slope to the freeway location (State of California, Department of Transportation n.d.c) (Figure 2).

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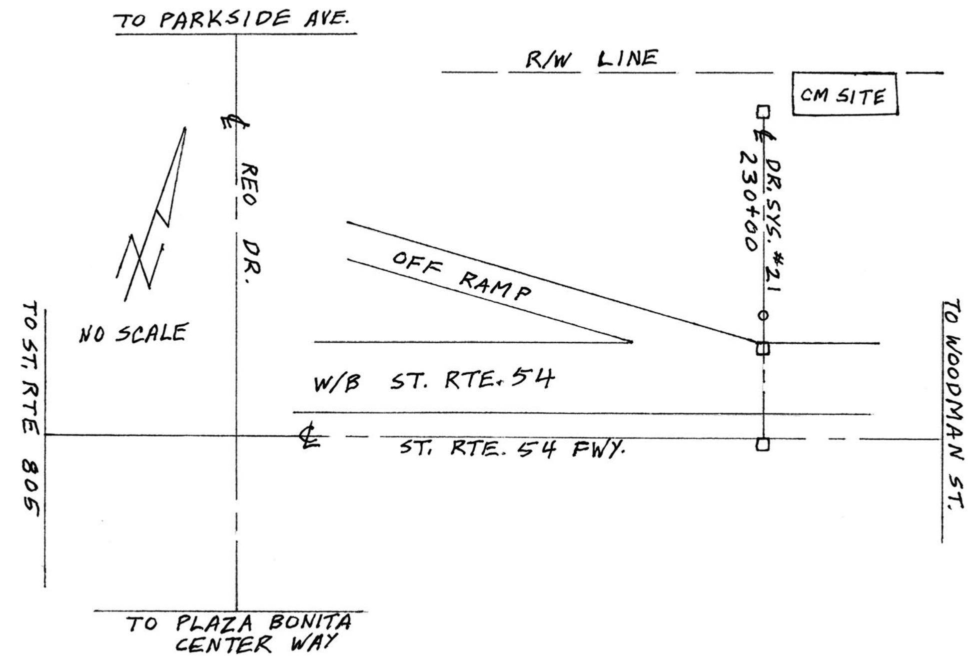

Figure 1 Cerutti Mastodon site location map in San Diego, California.

Notes: C combined with L, center line; Dr. Sys., drainage system; R/W, right-of-way; St. Rte., State Route; W/B, west bound.

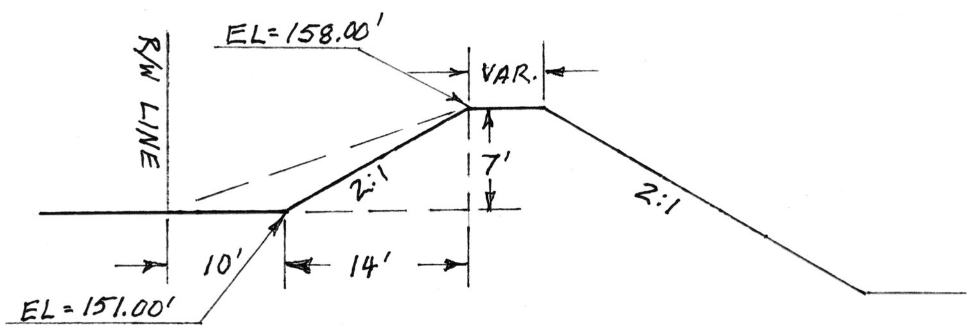

Figure 2 Structural cross section of the sound berm at station 230 + 00.

Notes: 2:1, slope ratio; el., elevation in feet above sea level; R/W, right-of-way; var., variable dimension.

In the area of the CM site, this construction was done using a Caterpillar 235C excavator (Holen et al. 2017, methods). It worked from the top of the ridge digging out material from south of the right-of-way line to form the access way and sound berm (Holen et al. 2018, 1). The excavator is a huge backhoe. It can reach out 39.4 feet and dig down 26.4 feet from ground level (RITCHIE Specs n.d.). It works by reaching out and scooping dirt back toward itself. It can rotate in a horizontal plane to dump material onto the ground, or into a dump truck for haul off. The bucket most likely used for this scooping would have been the 54-inch wide general duty bucket. It has a capacity of 2.62 cubic yards, and could fill a 5-cubic yard dump truck with two scoops (Caterpillar n.d.).

The berm originates about 800 feet west of the CM site by joining the existing high ground causing the access way to blindly end there (Personal observation, 4-10-2018). Access to the area between the right-of-way line and the berm during construction could only be made from about 350 feet to the east of the CM site where the ridge flattened out. Considering the sloping terrain and the narrowness of the workspace, the most practical way of removing the excavated dirt would be to back dump trucks in from the east, fill them, and drive out to the east. The work, progressing from east to west, would necessitate the trucks repeatedly crossing the CM site in two directions as work proceeded to the west end. The near proximity of residences would also require the use of a water truck to spray the area regularly for dust control, keeping the sediments moist between the right of way and the sound berm.

When that work was done, construction of drainage system 21 (State of California, Department of Transportation n.d.c) could begin. This is at station 230 + 00, at the west end of the CM site. As can be seen in a photo of the CM site excavation (Haaretz 2017), this work required the breaching of the sound berm for access of the drainpipe, construction of a drop inlet catch basin at the toe of the northerly slope of the sound berm, and the burying of a drainpipe down the south slope to join the rest of the drainage along the freeway. Materials for the construction of the catch basin seem to have been brought to the site and placed at the base of the sound berm, east of its location, as shown in another photo of the CM excavation (San Diego Community Newspaper Group 2017). The presence of the materials probably accounts for the lack of excavation in the north part of grid units H, I, J, K, L, and M (Holen et al. 2017, figure 1). At this point in construction the bones in the CM site were discovered, and controlled hand-excavation began (Holen et al. 2017, methods). A photograph taken from the top of the sound berm just east of drainage system 21 shows the site early during the CM excavation (Popular Archaeology 2017).

4. Grading to the north of the freeway

To the north of this area is the Bay Terraces Unit No. 3 tract (State of California, Department of Transportation n.d.a), which was developed about 20 years before the cited grading.

The tract was graded to conform to the general topography of the area with some slight modification to the above-mentioned ridge. These modifications did not directly disturb the CM site (State of California, Department of Transportation n.d.c).

Commonly this sort of grading turns up cobbles, which can be an impediment to later construction. If they are not too numerous, they are collected and deposited in areas on the site where they will not be a bother, such as along a boundary with an undeveloped freeway project. Evidence, which may suggest that this happened at the CM site, is provided in a photograph of a bulldozer filling in the site after excavation was completed (Zimmer 2017).

Stones can be seen to the left of the blade of the bulldozer, along the fence between them and the adjoining yard to the east. They were near station 230 + 65 ± and have been recently observed and photographed by the author in the same location (4/10/2018). They are of the same character as the stones described in Holen et al. (2017) and exhibited at the San Diego Natural History Museum. They are subangular andesitic cobbles and well-rounded granitic cobbles (Figure 3).

Figure 3 A photograph (taken by the author) of rocks in the back yard of the property to the north of the right-of-way line at station 230 + 65 ±. The pencil is 15-cm long.

5. Effects of construction on the CM site

The effects of construction on the CM site depend on the depth of burial and the particular location of the individual bones and cobbles. The reports give two elevations for the CM site, 149.2 feet (Deméré, Cerutti, and Majors 1995, 22) and 150.6 feet (45.9 m) (Holen et al. 2017, supplementary information, 29). Since the second agrees most nearly with the drainage system 21 (State of California, Department of Transportation n.d.c) top of inlet elevation, 151.00 feet, this elevation is used in the following discussion.

The Caterpillar 235C excavator was at all times working from the top of the sound berm, 7 feet or so above the CM site (State of California, Department of Transportation n.d.c) and never directly over the bones and cobbles. Therefore, over pressure from it would not have affected the CM site materials (Holen et al. 2018, 1). The plan called for it to dig out a 10-foot-wide access way, parallel to the right-of-way, and to match the elevation of the adjacent property to the north; and to form a 2:1 slope to the plan elevation at the top of the sound berm (State of California, Department of Transportation n.d.b). At the CM site this put the access way elevation at about the top of Bed E. The CM site was discovered when paleontological monitors observed mastodon bone and tooth fragments being unearthed from Bed E in grid units A1 and A2. Grid units B1, C1, D1, E1, B2, C2, and D2, were also partially disturbed by the digging (Holen et al. 2017, methods).

This author contends that the raking of the steel teeth on the excavator bucket across the CM site dragged the cobbles identified as anvils and hammer stones onto the site from the north, and could also account for the fragmentation of some of those cobbles, and the molar which was broken into three parts found in grid units C1, D2, and E3 (Holen et al. 2017, supplementary information, 3). This action also accounts for the anomalous attitude of CM56, the distal portion of a tusk thrust almost vertically into the ground. The back-dragging of a mass of material containing the tusk seems to have caused the tip to penetrate the weak sand of Bed D (Holen et al. 2017, table 1), and to catch in the less yielding silt of Bed C (Holen et al. 2017, 2) continuing to penetrate to a depth of 70 cm before breaking off at the level of the bottom of Bed E at a steep angle convex to the south, with sands from Bed D infilling along the leading margin (Deméré, Cerutti, and Majors 1995, 32). The weight of the 54-inch-wide general duty bucket is 2842 pounds (Caterpillar n.d.), and the weight of two and a half cubic yards of dry dirt is about 5000 pounds (Dan's Dirt & Gravel n.d.). This weight would supply enough force to accomplish the task.

Holen et al. (2017, 481) state that the CM56 anomaly "is interpreted as the result of purposeful placement." Explanation as to how this was done is not offered. In my capacity as a land surveyor, I have inserted items vertically in the ground, and do not accept the interpretation of the placement of this mastodon tusk. I have had to purposely place hardwood stakes two inches square and two feet long to mark property corners in sediments similar to those at the CM site. This has to be accomplished by first making a hole nearly as deep as the stake is to be set using a two-inch-diameter pointed steel rod driven into the dirt, then removing the rod and replacing it with the wooden stake, which has to be driven to ground level using an eight-pound sledge hammer. The whole operation requires 12 or more blows of the hammer in the best of conditions. The actions of the mechanical excavator seem to be a simpler explanation for the vertical position of the tusk than human actions in prehistory.

The impacts of dump trucks crossing the site must also be considered. This construction activity would have had serious compressive and distorting effects on the sediments and materials enclosed in them. The type of dump truck most commonly used in these sorts of situations is the "five yard" dump truck. The five yards refers to its volumetric capacity. The truck weighs 33,000 pounds (City of Abilene 2017), and five cubic yards of dry dirt weigh about 10,000 pounds (Dan's Dirt & gravel n.d.). This weight crossing to the west and east over the wet and very plastic 20-30-cm thickness of Bed E (Holen et al. 2017, supplementary information, table 1) must have affected the bones that the bed contained. First, they could have pressed the cobbles, drawn onto that surface by the excavator, into Bed E. Second, they could have worked the cobbles against the bones, crushing some, pushing others around, and establishing the puzzling anomalies seen. Somewhat analogous situations to this can be seen in cities where heavy buses driving on asphalt pavement cause damage at bus stops. When buses repeatedly stop to load and unload passengers on asphalt pavement, their weight causes the pavement to fail from compression and to form ripples in the street. This situation is remedied by replacing the pavement with stronger concrete pads in those areas (National Association of City Transportation Officials n.d.). Asphalt pavement is much stronger than the very plastic sediments of Bed E, so a greater effect can be expected in the CM site's case. The effect would be cumulative, getting worse with each crossing.

An estimate for the number of truck crossings can be derived from the design data given on the plan for drainage system 21 (State of California, Department of Transportation n.d.c). The area (A) of a cross section from the

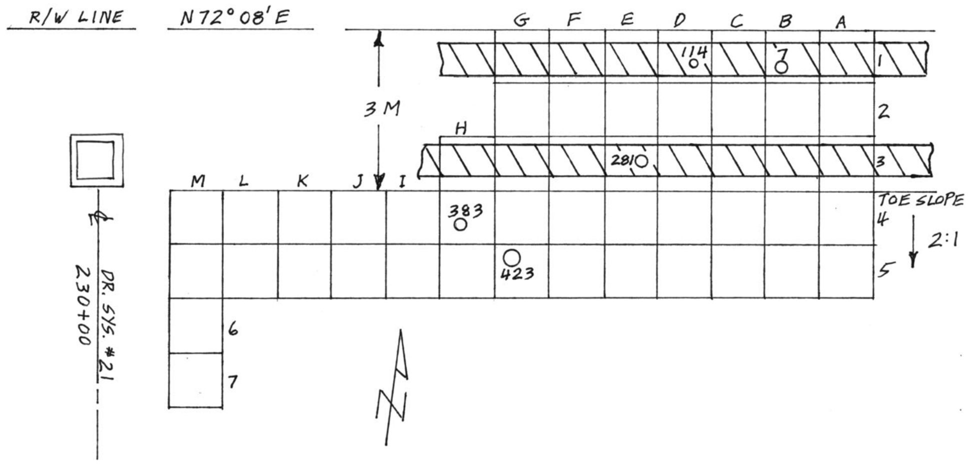

Figure 4 Plan view of the Cerutti Mastodon site.

Notes: the numbered circles indicate the cobble locations; the crosshatched areas show the path of the dump-truck tires across the site; 2:1, slope ratio; C combined with L, center line; Dr. Sys. drainage system; R/W, right-of-way.

right-of-way line to the top of the 2:1 slope to be constructed, assuming an existing straight slope between the points, can be calculated thus: $A = 0.5(7 \times 24) = 84$ square feet. Similarly, the area of the unexcavated material forming the 2:1 slope: $A = 0.5(7 \times 14) = 49$ square feet. The difference between the two is the area excavated, 35 square feet. This multiplied by the estimated distance from station 230 + 00 to the west end of the work, 800 feet, is 28,000 cubic feet, or 1037 cubic yards, or 207 truckloads. Even with a possible 25% error in the estimate either way, this means about 150–250 trips in and out, a not inconsiderable amount of traffic or damage.

The track that these trucks would make over the CM site can be calculated from the Mack CL703 chassis standard specifications (Truck Planet n.d.), and the General Tire specifications for the tire size 11R22.5 (General Tire n.d.) commonly used for "five yard" dump trucks. This chassis uses a two-tire-per-side configuration for the rear axles with a total outer edge width from tire-to-tire of 2.438 m. The tires are 0.282 m wide, and have a 0.564-m-wide footprint per-side. This footprint would be 0.15 m from each side of grid tier 2 onto grid tiers 1 and 3, and cover 56% of their areas. It would run over CM7, a hammer stone, and CM114, an anvil stone, and the refitted andesite cobble fragments of concentration 2 in grid tier 1, and CM281, an anvil stone, and most of the pegmatite cobble fragments of concentration 1 in grid tier 3 (Figure 4).

In Holen et al. (2017, extended data, figure 3a), a photograph shows an oblique view of concentration 1 in grid unit E3, taken from the west. Central in the frame is CM281, an anvil stone. To the left and below it is CM286, a molar fragment, and to the left and slightly above that is another un-numbered molar fragment (Holen et al. 2017, figure 1). Below CM286 is CM288, a spirally-fractured femoral bone fragment, and to the right of that is CM292, another spirally-fractured femoral bone fragment. In the upper right corner of the photograph are CM252 and CM285, two femoral heads more clearly seen in Holen et al.'s (2017) figure 3b. Arrayed below, to the left, and above CM281 are three un-numbered rib fragments. Another photo of a plan view (rotated 90 degrees to the right) of the same area (San Diego Natural History Museum n.d.b) more clearly shows the rib disposition relative to CM281 with the un-numbered molar fragment and an un-numbered pegmatite fragment (Holen et al. 2017, figure 1) removed. The rib to the left (now above) appears to have broken away from the one above (now to the right of) CM281; moreover, on the substrate to the left of (now above) it are numerous angular shards of what appears to have been pedogenic carbonate crust such as is seen *in situ* on the rib fragment above (now to the right of) CM281. Indeed, pedogenic carbonates seem to be otherwise absent from the other bone fragments and the femoral heads in these photographs. This suggests post-depositional disturbance of the site.

Taken as a whole, this evidence seems to indicate that CM281 was recently forced into concentration 1 by the tires of the dump trucks crossing the CM site, which concentrated the weight of the trucks on the stone, thus breaking and scattering the bones there, and pulverizing their brittle pedogenic carbonate crusts.

In addition to the damage seen in these photographs, more than 300 bone fragments were found in concentration 1, around CM281, and in concentration 2, around CM114, another anvil stone (Holen et al. 2017, 479). These fragments are identified as mostly femoral in origin (Holen et al. 2017, extended data, figure 2). The *Nature* letter contends that this bone damage was caused by ancient humans, using the cobbles as anvils and hammer stones for the purpose of bone-marrow extraction, and/or bone and molar tool manufacture (Holen et al. 2017, 482). It seems very antithetical to either of these purposes to smash the bones to this extent. It would scatter the marrow in the dirt, and destroy valuable tool-making material. It is, however, what is to be expected of dump-truck traffic over cobbles and bones at an active construction site.

6. Outliers

The other two hammer stones cited in Holen et al. (2017) were found in areas of the CM site that could not have been affected by the actions thus far described. While I cannot offer any direct evidence to explain the positions of these stones, there are circumstances which might indicate some problems there.

CM423, a pegmatite cobble found in grid square G5, is displayed in a glass case with refits found in concentration 1 at the San Diego Natural History Museum exhibit. These fragments show remarkably fresh-looking fracture faces. The faces sparkle in the lighting, and are un-dulled by any weathering or other alteration. One might expect to see some sign of chemical weathering considering 130,000 years of exposure to fluids, which promoted the heavy pedogenic carbonate crusts seen on some of the bones.

More problematic is hammer stone CM383 found in grid square H4 (Holen et al. 2017, extended data, figure 3e). This is an *in situ* plan-view photograph of CM383 and a nearby rib bone. A comparison of the sharp shadows cast on the substrate seems to indicate that the stone is at a higher elevation than the rib. A photograph of the same location taken at a more oblique angle from the east shows that this is indeed the situation (Haaretz 2017). The photograph shows CM383 supported on a column of sediment above the level of the rib. A scale card leaning against the column indicates that the stone is about 15 cm above the substrate, which appears to be the top of the Bed D contact. It is difficult to believe that the hammer stone supposedly used to cause the breakage of the bones at the CM site would not be lying on the same surface plane as the bones.

CM383 "exhibits macro- and microscopic wear on the surface that was found lying upward, with the under surface exhibiting a rougher surface texture" (Holen et al. 2017, supplementary information, 10). Nothing is said about pedogenic carbonate rinds in the cited discussion. Both photos show a partial carbonate rind on this specimen's upward surface, and the caption for figure 3e in the extended data calls attention to it.

The presence of this carbonate rind on the upper surface of the stone, as recovered, and the rougher weathered lower surface are factors at odds with the *in situ* formation regime for pedogenic carbonates described by Zamanian et al. (2016), who state that carbonate coatings develop on the bottoms of clasts, and "alteration in clast coating orientation (i.e., mostly at the bottom of clast) […] is an indicator of soil disturbance" (Zamanian et al. 2016, 7).

Proof for how these anomalies were created cannot be demonstrated from the facts available in the public sphere. I speculate that the five-month delay to drainage system 21 construction threatened by the CM excavation may have led the contractors to work on the site during the days when the CM excavations were not active. The necessary work required laying the pipe, building the forms for the catch basin, pouring the concrete, removing the forms, and back filling the catch basin site and the pipe line, all in a relatively constricted area. Although this work did not require access directly over the sediments of the CM site, it is possible that accidental impacts may have been made. These would not have become part of the CM site excavation records.

7. Summary

The limited goal of this paper is to investigate whether modern construction activity offers a more reasonable explanation for the anomalies seen at the CM site, as opposed to human activity 130,000 years ago. A study of the freeway grading plan and right-of-way map demonstrates that access to the work site could only be had from east of the CM site, and requires that many dump trucks cross over it. Analysis of a contemporary excavation site photograph shows that cobbles, similar to the ones discovered in the CM site, are present in a back yard near the CM site. This author's recent examination of the location found those cobbles. Further, at the time of discovery, paleontological site monitors observed the excavator raking up bone and tooth fragments at the east end of the CM site. Such action, unobserved, may have drawn cobbles into the CM site prior to its discovery. The track of the dump trucks over the CM site has been calculated, and it crosses the two concentrations of broken femur bones, each centered on a large cobble. The cobbles seem to have concentrated pressure from the heavy trucks onto the bones, crushing them into more than 300 fragments. This is far more damage than is necessary either to harvest marrow, or to obtain material for tool manufacture.

8. Conclusion

To conclude, as in Holen et al. (2017), that damage to bones in a site surrounded by heavy earthmoving construction was caused by ancient humans, without questioning the possible effects of that earthwork, is a noteworthy omission. Even if work at this particular location went unobserved for the two months (Deméré, Cerutti, and Majors 1995, 1; San Diego Natural History Museum n.d.a) or so before site discovery, the fact that so much had happened there before discovery should have been obvious. My reconstruction of events, based on construction plans, common construction practices, contemporary photographs, and direct observations, although in some sense circumstantial, offers a viable alternative explanation for the damage found.

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Disclosure statement

No potential conflict of interest was reported by the author.

Notes on contributor

Patrick M. Ferrell is a licensed Land Surveyor (L 6775) in the State of California with more than 30 years of experience in freeway and road construction, 19 of those with the California Department of Transportation. He holds a Bachelor of Science degree in Geology from California State University, Long Beach.

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