



UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

SEP 28 1981

MEMORANDUM FOR: Robert E. Jackson, Chief
Geosciences Branch, DE

THRU: *SSJ* Stephan J. Brocoum, Leader
Geology Section, GSB, DE

FROM: Anthony T. Cardone, Geologist
Geology Section, GSB, DE

SUBJECT: SAN ONOFRE 2 & 3 NUCLEAR PLANT SITE

The purpose of this memorandum and its attachments is to compile and record the presentations to the San Onofre 2 & 3 hearing board made by Mr. David Phifer and myself in regard to faulting at the SONGS site postulated by Mr. Phifer. Also noted are the field trips meetings etc. in the same regard.

On June 25, 1981 Mr. Phifer made a presentation to the San Onofre 2 & 3 hearing board in which he presented information on 3 postulated faults on Camp Pendleton. He named them the Horno Canyon, the Horno Summit, and the San Onofre Mountain faults. Attached is the transcript of Mr. Phifer's presentation to the hearing board made on June 25, 1981.

As a result of Mr. Phifer's statements, the board requested that the NRC staff evaluate the new information and report back to them. In order to get as much information as possible, expeditiously, I attended a field trip to Camp Pendleton on June 27, 1981 to investigate the postulated faults. I was accompanied by the applicant and its consultants, Mr. Phifer, and personnel from the Camp Pendleton staff. Ken Lajoie of the U. S. Geological Survey also attended at the invitation of Mr. Phifer.

On the basis of this field examination I requested that the Applicant perform some studies regarding the terraces that straddle the Horno Summit fault along San Onofre Creek and also along San Mateo Creek, and also to look along its trend for continuity as well as looking at the other faults for dating evidence and continuity. The Applicant provided a final documentation of the results of their studies on July 29, 1981. A copy of the applicants report is attached.

I made a presentation, the transcript of which is attached, to the hearing board on July 31, 1981 in which I concluded:

1. There is evidence for strike-slip faulting along the trend of the postulated Horno Canyon fault. However along the inferred trend of the fault are two undeformed terrace levels that truncate the fault. This would indicate an age of faulting of at least 300,000 years old for the upper terrace level and of at least 120,000 years old for the terrace platform observed in the sea cliff. There is no basis for the existence of the Piedro de Lumbre leg of the Horno Canyon fault.

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2. The postulated San Onofre Mountain fault is evidenced by hummocky ground at the base of a series of high, arcuate escarpments which are very indicative of landsliding rather than a tectonic origin. Therefore, there is no evidence to support this fault as postulated by Mr. Phifer.
3. There is evidence of faulting along the trend of the postulated Horno Summit fault in several places. However, the terraces that straddle the fault at San Onofre and San Mateo Creeks, which are dated by Dr. Schlemmon at 40,000 to 100,000 years old are not deformed.

The fault was described as having strike-slip movement of some 20 miles. However, the evidence for this presented by Mr. Phifer is erroneous for the following reasons. His estimate of right-lateral displacement of up to 20 miles on the fault was based on his observing San Onofre Breccia displaced "across a couple of miles of Eocene." He stated that the breccia was picked up somewhere along the fault and moved to an area where no breccia is known to exist. However, the evidence shows the breccia boulders were not moved by tectonic forces along the Horno Summit fault but most likely was moved some miles distant by truck from a quarry site to serve as road ballast. Also, the applicants air photo study indicate that there are no lineaments of structural origin that align with the postulated fault. Lastly, if the Horno Summit fault did exist it would be approximately 5 miles distant, at its closest point, from the plant site. Since the OZD is also 5 miles from the site, it is the more prominent of the two faults and would therefore be the controlling fault.

In conclusion, I did not see anything in Mr. Phifer's presentation regarding the postulated faults that might pose a hazard to the San Onofre site.

I have reviewed the additional information provided to the board by Mr. Phifer on July 31, 1981. There is nothing in this new information that would cause me to change my conclusion stated above.


A. I. Cardone, Geologist
Geology Section
Geosciences Branch, DE

Attachments:
As stated

1 and if we need to fill it in, we will do it on that basis.

2 MR. PHIFER: Is that satisfactory?

3 JUDGE KELLEY: Well, why don't you go ahead, and
4 we will fill in as necessary.

5 PRESENTATION OF.

6 DAVID PHIFER

7 My name is David Phifer. I presently reside at
8 944 Styles Court, in Vista, California. I am currently
9 employed by a small engineering firm in North San Diego
10 County. I have been with that firm for two-and-a-half years.

11 I have no financial interest in the San Onofre
12 Nuclear Plant, or the companies associated with its
13 construction or operation.

14 Today I represent myself as a private citizen.

15 My background, educationally, I attended the
16 University of Washington from 1951 to 1955, and there received
17 a Bachelor of Science degree in zoology. I attended the
18 Naval Post-Graduate School from 1970 to 1972. About 30 hours
19 of my studies were in marine geology, oceanography, and
20 related sciences. I returned to the University of Washington
21 in 1977 and 1976 -- '76 and '77, and took two quarters of
22 work, about 20 hours, out of the Geology Department, and with
23 the Oceanography Department.

24 After returning to San Diego in the spring of
25 1977, I periodically attended San Diego State University, in

1 graduate status, taking courses under Dr. Marshall and a
2 number of others.

3 My lifelong interest has been geology, although
4 I also graduated from the School of Hard Knocks, called the
5 U. S. Marine Corps, 21-and-a-half years service.

6 I have informally studied the geology of
7 Margarita P Quadrangle, at Camp Pendleton, and related areas,
8 since 1956, whenever the Marine Corps brought me back, and
9 have notes that go back before that period.

10 Sir, I will stop now, and if there is anyone who
11 has any questions, as far as my qualifications, or my
12 background, I would be pleased to answer them.

13 JUDGE KELLEY: I think you have pretty well
14 covered it. Why don't you go ahead.

15 MR. CHANDLER: Mr. Chairman, only one very small
16 request:

17 Mr. Phifer, is your name spelled P-f-e-i-f-f-e-r?

18 MR. PHIFER: My name is spelled P-h-i-f-e-r.

19 MR. CHANDLER: Thank you, sir.

20 JUDGE KELLEY: You can go ahead.

21 MR. PHIFER: One more comment:

22 My history goes back to 1932. I am 49 years old,
23 I guess that would make it.

24 As a personal friend of Tom Thompson and
25 Robbie Robinson, Auderbach(ph), in oceanography. They used to

1 bounce me on their knees.

2 This morning, ladies and gentlemen, Members of
3 the Commission, I am going to try to be brief and candid.
4 I have new information. I want to discuss it with you at
5 three levels: first off, present the data, then I will try
6 and to relate the data as in my interpretation I see it. I will
7 try to keep data and interpretation separate.

8 I will do this on a local level first. I will
9 then do, and relate it into an interpretation on a regional
10 level. After I get done there, I will wave my arms a little
11 bit for those guys who like plate tectonics.

12 There are three major unreported faults on
13 Camp Pendleton. For purposes of discussion, and for
14 subsequent papers, they will be called the Horno Canyon Fault,
15 which embraces this, the Horno Summit Fault, which is this
16 in the center of Camp Pendleton, and the San Onofre
17 Mountain Fault.

18 About ten days ago the data started to fall
19 together for me. I saw of the displacement of some terraces,
20 and I went back on Saturday last to field check. The
21 structural features are there.

22 Let us talk about the Horno Canyon Fault. Here
23 across a scarp that goes across the Roblar Road --
24 cretaceous plutons with jurópliasic(ph) streams in them,
25 against La Jola group Eocene, facing a thosand foot scarp.

1 I sensed the up and the down, based on that
2 scarp, and some other data.

3 Here at Horno Canyon, and I think it goes down
4 the trace, there are slicken sides on the surface, and
5 vertical surface gouges in the rock that go about ten to 15
6 meters, and some small ones.

7 Just to the north, and I am going to talk terraces
8 now, because some of the evidence is geomorphic. I am going
9 to talk lower terrace, number one. A second terrace is in
10 green on my map. A third terrace is in yellow on my map,
11 and the fourth terrace in blue.

12 On each side of Horno Canyon, the fourth terrace,
13 the blue terrace, stands at 800 feet. This is aphysiographic
14 level. This is not a terrace level, as such. It probably
15 has alluvium and colluvium on it; I just haven't been up
16 there yet.

17 South of Horno Canyon, what I correlate, and the
18 correlation is based on the position of the terraces relative
19 to one another, it stands at about 600 feet. That is
20 approximately. It is an interpretation, no facts now, just
21 interpretation, 200 feet vertical displacement.

22 If we trace down to Piedra del Hombre Canyon
23 just to the north of Bogus, we can see terrace No. 2, the
24 green terrace, standing at aphysiographic, at an elevation of
25 300 feet.

1 To the south, between Piedra del Hombre, and
2 Bogus, the terra stands at 200 feet. Again, an interpretation --
3 That is 100 feet of vertical displacement.

4 It appears that the fault is a high-angle normal
5 or reverse fault, with the last movement, as testified by
6 the slicken sides, being lateral, and that is why the question
7 marks are down here.

8 There are slicken sides that go this way, and there
9 are slicken sides that go that way -- or this way, whichever
10 way you want to call it.

11 The Horno Summit Fault--

12 MR. PIGOTT: Excuse me, could we have directions
13 on which way you are saying the slicken sides go? "This
14 way" and "that way" don't show up very well on the record.

15 MR. PHIFER: The slicken sides are close to
16 horizontal.

17 MR. PIGOTT: And the sense of movement? East-west,
18 north-south? If you could use those directions.

19 MR. PHIFER: The sense of movement is northeast-
20 southwest.

21 The Horno Summit Fault:

22 Here, at Oceanside, in Lawrence Canyon, Pliocene
23 San Mateo is faulted against Miocene San Onofre breccia.

24 Here, up the trace, and it is difficult to see,
25 San Onofre breccia is juxtaposed against La Jolla group and

1 probably Santiago.

2 Here, at Bogus Canyon, there is a hard sandstone
3 marker bed that stands on the west side of the fault. I
4 think it is the west side -- Pardon me, just off the east
5 side -- You can't see it -- again, overlying cretaceous
6 trebodites at Bogus Ammo Dump, if you drive by on the road.

7 Here, on Horno Ridge, above Horno Canyon, at the
8 same elevation, trebodites, brown sandstone, probably
9 La Jolla group -- pardon me, probably Point Loma, but
10 cretaceous, surely, are butted up against Eocene massive
11 archosic sandstones. The zone is -- I don't know how wide,
12 but there is a zone there three or four meters wide. It is
13 purple. I think it is part of a hydrothermal alteration.

14 Here, crossing Range 214, just to the north of
15 the south fork of the San Onofre Creek, the fault is exposed
16 vertically for 30. On the east side we see trebodites,
17 probably cretaceous. On the west side, Eocene sandstone.

18 I cannot sense, from the topography the magnitude
19 of the slippage, or the magnitude of movement. I can tell
20 you the zone is kind of narrow. It is broken, broken, broken,
21 broken, but it is kind of broken. You can stick your fist in
22 it, and you can feel it gouges there.

23 Down here, we have -- I saw a few more little
24 fractures in the San Onofre down here on Vandegriff Boulevard,
25 and we can measure those.

1 Here, at Mateo Canyon, on the north side, the
2 hard sand-- same old hard sandstone caps the stream terraces,
3 the same brown sandstone that we saw here.

4 Down on this side, the sandstone stands up on the
5 top of the stream terrace, stepping about 15 degrees to the west.

6 Down in the little hole next door, there is a
7 sliver, maybe 100 meters long. It dips at 15 degrees. On
8 that projection, it is about -- the vertical displacement is
9 about 200 feet.

10 Something I have yet to verify, but here, also,
11 where the sandstone comes up, just beneath it, in the float,
12 there is all sorts of blue schist, and typical San Onofre
13 breccia material that does not crop out.

14 MR. PIGOTT: Excuse me. That is an area on the
15 map just south of San Mateo Creek, is that correct?

16 MR. PHIFER: Just south of San Mateo Creek.

17 I would infer that since it is very difficult to
18 get San Onofre breccia across a couple of miles of Eocene,
19 on a structural trend like this, that that San Onofre breccia
20 was picked up somewhere along on this line and moved to
21 there. Therefore, my interpretation is that the sense of
22 movement is right lateral, the direction of movement is
23 northwest-southeast.

24 The San Onofre Fault -- By the by, this fault was
25 mapped -- This is Moyle's map. This fault was mapped this far

1 by Moyle. It was mapped this far by Moyle. He put these
2 little fractures here. He also picked up, and at least
3 Webber had it before, so Smith must have done it, this fracture.
4 The state map, and I am told from the boys in San Francisco
5 that they compile it, that this data on this fault coming
6 across to about here is Smith's data.

7 Boss and Werts, in '58, basically said: This is
8 a depositional contact in here, what I now show as a fault
9 contact. It is a reasonable interpretation, in the rolling
10 terrain and poor exposures.

11 The San Onofre Fault looks to be a branch of
12 the Cristianitos, and it is mapped on all the big maps as
13 this fracture here. There is an inferred fault here. There
14 is an inferred fault here. There are a lot of little breaks
15 in between. It is mapped as a depositional contact, Eocene
16 against Eocene under Miocene. I think it is a fault.

17 There is a hell of a scarp that goes through
18 there. I haven't been up there in years, but you have
19 Eocene near the top. You have Eocene and Miocene butted
20 against each other, and if she underlies all the way, it is
21 kind of difficult to do. I think it is a high-angle normal
22 fault.

23 / / /

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1 Geomorph: A pronounced scarp behind San Onofre
2 Mountains, A pronounced scarp across through Zulo area
3 through Roblar Road; it's 1,000 feet high.

4 Aliso Creek, Horno Creek, Bogus Creek, Piedra del
5 Hombre Canyon(ph).

6 Horno: A large drainage basin that, as the
7 stream goes to the sea, cuts a knife edge through a block
8 coming up.

9 Piedra del Hombre, the same thing. The canyon
10 is not more than 20 meters wide on the bottom. The drainage
11 basin is a mile or two across, a half mile.

12 Aliso Creek: Almost trapped.

13 Bogus Creek: Narrows down.

14 Terrace One: Apparently unbroken. Terrace One
15 the plant sits on Terrace One.

16 Terrace Two: A hundred feet vertical offset
17 at Piedra del Hombre.

18 Terrace Three: I don't know.

19 Terrace Four: Someplace between 200 and 500 feet
20 of offset at Horno Canyon. About 300 feet of offset back here.
21 This again is geographic evidence interpretation.

22 The last thing, the lineal trends; they fit.
23 This is a tier fault.

24 My conclusions: The faulting is recent.

25 The lads from Woodward tell me that Terrace One

1 is something around .14 million years old. I wish somebody
2 would correct me if that's not right. I understand that's on
3 the basis of amino acids.

4 I guess that these terraces which come up so well
5 and so nicely to the mountain are on the order of half a
6 million. I would say I base that on my guess on the physiography
7 of the degree of dissection. I can't prove it.

8 I am told that the offshore zone of deformation,
9 just above it, there's a 17,000-year surface.

10 My conclusion: It's pre-Holocene, somewhat older
11 than the last 10,000 years.

12 It's post mid-Pleistocene. That's the window, I
13 think, and I'm not sure about the backside of the window.

14 Conclusion two: Faulting is large scale. Maybe
15 vertical offsets of 500 feet or more. Maybe lateral offsets
16 of 20 miles.

17 Point three: Based on the length of fault
18 breakage and Hausner's empirical correlation, we are looking
19 at something between 6.5 and 8. And my slight knowledge of
20 seismicity tells me that's about 1 g at the plant.

21 Let's see how it fits regionally.

22 I think it goes back here, up high, 2800 feet,
23 there's 150 feet of flatland basalt. There are a number of
24 little fractures, one of them which has about 26 million tons
25 of the highest grade ceramics you ever saw.

1 The basalts were pushed up on that site and dropped
2 down on this site; pushed up on the west and dropped down on
3 the east.

4 There's a big scarp that's part of the Deluse
5 Canyon back in there. It looks like this big scarp goes
6 right through the Roblar-Luco Granite(ph) and back in here.
7 I can't prove that. Here's where it goes right there. See
8 that piece of Luco granite right there? I can't prove that.
9 So it fits regionally. At least it's not contradictory.
10 Hooray.

11 I just talked to Monty. We aren't sure about
12 those basalts. Perry says that they're about 8 million years
13 old. The surface around it is flat as hell. They bake the
14 surface; there is old soils underneath it. I haven't gotten
15 back in there with a backhoe to jerk out any wood or whatever
16 else we can find. I don't know. We'll have to go back and
17 look at the data. I think they're younger. I think the
18 basalts are younger; therefore, the surface is younger. And
19 if it's faulted off, it's faulted off.

20 Let's go to a little bit of -- Catalina Fault,
21 Rose Canyon, Elsinore, San Jacinto, San Andreas. Eric Frost
22 taught me how to do this. That's compression. That's
23 tension.

24 Now what we're seeing is a lot of vertical
25 displacement. We're seeing them on some tear faults. Here's

1 the big one. Here's our little baby right here. Here's that ¹⁴²⁸
2 little tear fault and she looks like that jumped up and that
3 went down. Here's that other little San Onofre. This looks
4 up. The terrace is out here. This looks down. There's
5 compression. She's getting pushed together.

6 And regardless of what some people have said, the
7 easiest way is up.

8 We're in the southwest quadrant of a shear couple.

9 Now may I suggest some additional lines of
10 evidence that I'm going to need some help with? I'm going
11 to try to get Monty to work with it.

12 Let's go to some places on this map, or, better
13 yet, let's go to some places on the other map.

14 Here at Horno Summit there's a little plug. They
15 say it's a tertiary plug. It's latite(ph), quartz latite.
16 I think we can drill it, Monty, and get the paleomag out of
17 it. I think it's right on the fault. I think it came
18 through because it's weak there. The same thing at Cielo
19 de Calavera down in Carlsbad.

20 Besides this, in my geotech work, I have been
1 mapping all the little tears down here. The general trend
2 is this way. There's some cross fractures, some tear fault.

3 I think we can go to Morro Hill on the south end
1 of Camp Pendleton, another dachite(ph) plug and get paleomag
out of that.

1 I haven't yet paid my \$75 for the aerial
2 magnetics of this area. We ought to look at that.

3 Shawn Bealer(ph) just sent me a first release of
4 the gravity for this area, the Santa Ana Sheet. I haven't
5 had a chance to analyze that. I don't see anything
6 startling around San Onofre Mountain on the first cut, but
7 then you never know about Bogus(ph) gravity.

8 Thank you for your attention.

9 I'd entertain any questions you may have.

10 JUDGE KELLEY: Thank you, Mr. Phifer.

11 Let's see if the counsel do have questions they
12 want to put to you.

13 Mr. Pigott?

14 MR. PIGOTT: I would prefer not to question
15 Mr. Phifer on a limited appearance basis at this time. I
16 think this is probably the fullest statement we've had from
17 Mr. Phifer. Some of our people have in the last few days
18 talked to Mr. Phifer.

19 I would prefer not to respond until we have had a
20 chance to put together a responsible response.

21 MR. PHIFER: Thank you. I am sorry I have talked
22 in fragments to some of your people. I did that because I
23 didn't realize the import of what I had. I realized the
24 import; I didn't realize all the limitations, so you have
25 to go back and look at the map and tromp around the field

1 until you know.

2 JUDGE KELLEY: All right. Let me ask Mr. Wharton.
3 Do you have questions?

4 MR. WHARTON: Yes. It sounds quite significant
5 to us. We would like to have a map and the data and have
6 an opportunity to talk to Mr. Phifer a little bit further if
7 we can arrange that with either Dr. Brune or someone else
8 from our side.

9 MR. PHIFER: Sir, the map is public record.
10 That's why I came here today. My data is always at anybody's -

11 MR. WHARTON: Yes. But we're talking about the
12 lines that you have on the map which you have today. That's
13 just what I would like to have.

14 MR. PHIFER: That's the only one I have. I
15 can make another one in 20 minutes; okay?

16 MR. WHARTON: I'd appreciate that.

17 JUDGE KELLEY: I would urge you, Mr. Phifer, just
18 as a general matter. Some or all of the parties may want
19 to file up and talk to you and I would request your cooperation
20 in answering their questions and so forth.

21 MR. PHIFER: I work. And I would ask you not to
22 call me at my office because I have a job to do there for
23 another man and I have taken a little bit of his time now.
24 I would prefer that you do not.

25 For those of you who are geologists or lawyers

1 and have shoes -- Ken LaJoy and I -- Ken is going to call
2 me tonight. He's mapping the terraces, trying to correlate
3 them up and down the coast. He has several lads working.
4 I promised him to take him up and show him the terraces at
5 San Onofre on Saturday. No, we won't leave from the Colony
6 Kitchen in Oceanside at 6:00 o'clock in the morning, but we
7 will leave promptly and shortly thereafter.

8 Thank you.

9 JUDGE KELLEY: Let me just ask Mr. Chandler.

10 MR. CHANDLER: We intended to get a hold of
11 Mr. Phifer the other day without success. I think he has
12 presented an awful lot of material and we would certainly
13 like to consider it.

14 We would be most anxious to get a copy of this
15 map with the lines he's drawn on it. I'd appreciate that.

16 MR. PHIFER: It's yours.

17 JUDGE KELLEY: Mr. Phifer, from the Board's
18 standpoint, what we normally do in a case like this and what
19 we would propose to do here is, when new information comes
20 to our attention that may have a bearing on a case and it's
21 technical information, we will typically ask the staff, as
22 an initial step, to evaluate it and report back to us and
23 see where we go from there, and I think that's what we will
24 do in this case.

25 Let me thank you very much for coming and for

1 sharing your information. I think for a person to do this
2 kind of work and come forward just as a private citizen is
3 a very commendable thing and we appreciate it very much.

4 MR. PHIFER: It was a hell of a decision.

5 JUDGE KELLEY: I appreciate that too, sir.

6 MR. PHIFER: There are a lot of good men who
7 worked on this project; a lot of money in it. I feel bad
8 about this. We need the power, but there's 10 million people
9 downwind.

10 JUDGE KELLEY: Thank you, sir.

11 MR. WHARTON: Mr. Phifer, what is the best number
12 and time to call you so I don't interfere with your work
13 time?

14 MR. PHIFER: After 6:00 at home.

15 MR. WHARTON: Could you write that down here,
16 please?

17 MR. PHIFER: My home phone number for any of
18 you who may want it is area code 714, 726-1394.

19 MR. WHARTON: Thank you very much, Mr. Phifer.
20 I really appreciate it.

21 JUDGE KELLEY: Thank you.

22 We will be in recess.

23 (Brief recess)

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1 evidence in this proceeding. It is in response to a limited
2 appearances statement.

3 JUDGE KELLEY: I understand it is not coming in
4 as substantive evidence, but as you described it.

5 Whereupon,

6 ANTHONY THOMAS CARDONE

7 resumed the stand and, having been previously duly sworn by
8 the Chairman, was examined and testified further as follows:

9

10 WITNESS CARDONE: This is the map --

11 MR. PIGOTT: Could we have the map turned just
12 slightly, Mr. Cardone, so that we can see it from the audience?

13 JUDGE KELLEY: You are going to have to pick up
14 a mike too, I think, Mr. Cardone, if the wire will accommodate
15 you.

16 WITNESS CARDONE: This is the map that Mr. Phifer
17 offered to the Board --

18 JUDGE KELLEY: Are you picking that up? Okay.

19 WITNESS CARDONE: -- on June 25th. It illustrates
20 the -- his postulated faults and it is as he drew it. This
21 is the actual map that he drew. It is not a copy.

22 Now, the faults that he postulated are the Horno
23 Summit fault, the Horno Canyon faults, the Piedro de Lumbre
24 faults and the San Onofre Mountain faults.

25 Now, parts of these postulated faults are mapped

1 in -- by Moyle, 1973. This is Moyle's map as a matter of
2 fact. And they are also shown on the geologic map of
3 California, 1965. Now, I am indicating that part of these
4 are shown on these different maps, and also on the fault map
5 of California, 1975.

6 And the parts that were previously shown or
7 mapped are this inferred portion of the Horno Summit fault,
8 a portion here that is shown as a solid line which is a mapped
9 fault versus an inferred fault, and some an echelon type of
10 apparent structures, also Moyle shows this part as being --
11 shows this on this map, '75 and a '73 map --

12 BY MR. CHANDLER:

13 Q Mr. Cardone, when you say here and point, the
14 record doesn't show, so --

15 A The Horno Summit fault that I previously indicated
16 is -- it parallels the coastline and is about four to five
17 miles inland from the coast. And the -- in kind of a north-
18 westerly direction as is the coast. The Horno Summit fault
19 is perpendicular to the coastline, trending northeast, south-
20 west, as well as the Piedro de Lumbra fault.

21 The San Onofre Mountain fault parallels the
22 coastline and is a mile or two inland from the coast. The
23 portion that is shown as an inferred fault on the Humboldt --
24 or the Horno Summit fault on the Moyle map is on the north
25 end -- the northwest end of the map, and there are indications

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1 on the south end.

2 The portion that is shown on the Moyle map is
3 on the northeast end of the Piedro de Lumbré and the San
4 Onofre Mountain fault is also indicated on the Moyle map on
5 the north end of that postulated fault by Phifer.

6 The California maps that I earlier mentioned show
7 part of the Horno Canyon fault and part of the -- the part
8 being the northeast part of what is indicated on the Phifer
9 map of the Piedro de Lumbré fault also.

10 And I believe that is all that is shown on the
11 California maps. These others that are inferred by Moyle
12 are not shown on the map. By the way, this is our familiar
13 Cristianitos fault here, if there is any question about that.

14 Now, I -- we made a field examination on Saturday,
15 June 27th, a couple of days after Mr. Phifer appeared before
16 the Board, and we made a number of stops, and on the basis
17 of this field examination I requested that the Applicant per-
18 form some studies regarding the terraces that straddle the
19 Horno Summit fault in San Onofre -- along San Onofre Creek
20 and also along San Mateo Creek, and also to look along the
21 trend here to look for discontinuity or continuity, whatever
22 the case might be, as well as looking at the other faults
23 for evidence -- for dating evidence as well as continuity
24 or lack thereof.

25 The Applicant provided a final documentation of

1 their studies a couple of days ago, July 29th, I think it was,
2 and on the basis of my own analysis and the analysis provided
3 by the Applicants, and my field examinations, starting with
4 the Horno Canyon fault, the -- specifically what Phifer --
5 Mr. Phifer indicated was a strike-slip horizontal striations
6 on the wall of the Horno Canyon about in this area, and some
7 inferred offset of the terraces in this area.

8 He took this to indicate faulting. Of course,
9 the striations -- there is little doubt about that indicating
10 faulting, but in my opinion, there is a misinterpretation
11 of what is shown here. The apparent offset of these -- this
12 yellow band of closed geometric figures is the alignment of
13 terraces, and they appear to turn here, but that is due pri-
14 marily to differential erosion, where there is a thicker
15 deposit of San Mateo -- no, San Onofre Breccia and it thins
16 in this direction and you have more of the Miocene, or rather
17 the -- let me think a minute. Well, it is a softer formation
18 that overlies the San Onofre Breccia. This was incised more
19 so in this area --

20 Q Mr. Cardone --

21 A -- than it was here.

22 Q This area, again --

23 A It was incised more so south of where the Horno
24 Canyon fault projects to the coastline than it was north of
25 that Horno Canyon projection, so this, indeed is an erosional

k6
1 feature versus offset due to faulting, plus the -- I looked
2 across the projection of this fault and found that there is
3 no displacement of the terraces through here. Also,
4 Dr. Shlemon has mapped this entire area. That is, he has
5 mapped the 120,000 year old terrace along this entire line,
6 so there are two checkpoints, if one were to infer a continu-
7 ous fault here it is dated and truncated by the elevation --
8 325 foot elevation terrace, which is according to Dr. Shlemon
9 age dating approximately 300,000 years old, and this one by
10 the seacoast is 120,000 years old.

11 The Piedro de Lumbré fault, I think again, if the
12 S shape in the terrace, the terrace alignment influenced
13 Mr. Phifer to put a fault here, as well as -- he was looking
14 at what he thought was similar or equivalent terraces across
15 this projection of the fault, but actually he was looking
16 at two different types of terrace, one being the marine
17 terrace, and another was this terrace -- it is a stream
18 deposited terrace. It is a fluvial terrace. And he observed
19 the difference in elevation but that is no surprise, because
20 they are of different origin, so in my estimation that elimi-
21 nates this leg of the Piedro de Lumbré fault.

22 The San Onofre Mountain fault passes through some
23 very hummocky ground here and which is at the base of a high
24 escarpment on the east side of San Onofre mountains. Now
25 this -- these characteristics influenced Mr. Phifer to put a

k7
1 fault here, where actually I think -- well, my opinion is
2 that they are due to landsliding. The hummocky ground here
3 being a very obvious landslide feature, as well as the high
4 escarpment which is a back scarp of a landslide. They are
5 arcuate which is quite indicative of a landsliding. And all
6 of this was inferred, probably this was following a deposi-
7 tional contact, versus any indication of faulting.

8 Thirdly and lastly, the Humboldt -- the Horno
9 Summit fault had indications of faulting at several places.
10 As a matter of fact, probably a half a dozen, including here,
11 here. There was at the firing range here, I think it is
12 214 firing ranging, there was an indication of faulting some-
13 where within a terrace area here, and also in here, and a
14 couple of other places. And that was pretty much a long
15 trend, and I think the strike was pretty much along the
16 strike of his postulated fault trend.

17 Well, the Applicants found a continuous -- and I
18 observed that in a second field visit -- a continuous bed,
19 resistant sandstone bed that passes -- that spans the pro-
20 jected Horno Summit fault, which appears to be undisturbed.
21 Also, these terraces -- Dr. Shlemon has dated the terraces
22 from 40 to 100,000 years, I believe, pretty much the same
23 age terrace. The lower terraces, these are underformed where
24 they span the Horno Summit fault.

25 By the way, Mr. Phifer had this as a lateral

x8
1 fault with a displacement of some 20 miles, is the way he
2 stated it back in June 25th, and on the basis of observing
3 some San Onofre Breccia here, and I guess it must -- the
4 situation must be that you don't find San Onofre Breccia
5 until you -- for 20 miles along this trend, where it would
6 have to -- where it would have had to originate.

7 Well, the fact is that he was looking at some
8 boulders of San Onofre Breccia which is used by the Camp
9 Pendleton personnel for road servicing. They were rather
10 large boulders.

11 There is to my knowledge and the Applicants'
12 knowledge no indication of San Onofre outcrop or in place
13 at San Onofre in this area. It was transported, in other
14 words.

15 Now, along with some discontinuity or a demon-
16 stration of discontinuity along the Horno Summit fault here
17 and the undisturbed terraces, a -- the Applicants studied
18 some air photos, and I have some air photos that you might
19 look at. They actually studied lineaments in the area and
20 checked the lineaments to determine if they were of struc-
21 tural origin.

22 JUDGE KELLEY: Maybe you could pause for just a
23 moment, Mr. Cardone.

24 WITNESS CARDONE: They are on the table, there.
25 They were.

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JUDGE KELLEY: Did you want to comment on specific features of the photos?

WITNESS CARDONE: Not -- no, not really. And here --

The bottom part of that should be -- you can see the result of the lineament analysis -- there are a number of lineaments that were looked at, and the result is -- this would be the resolution of whether --

JUDGE KELLEY: I am afraid we are losing you entirely. Partly the mike and partly this would be -- because we don't know what this is.

WITNESS CORDONE: Okay. I may be getting into more detail than is necessary, but --

MR. CHANDLER: Staff tries to do a thorough evaluation.

JUDGE HAND: I am sorry.

1 MR. CHANDLER: Mr. Cardone, if you would try and
2 describe on the record where the "heres" and "theres" are,
3 I think it will be useful.

4 WITNESS CARDONE: This is the general area that
5 was looked at by the Applicant, where a lineament study was
6 made, and the area that -- of interest to us, here is the
7 San Onofre site.

8 JUDGE KELLEY: Could we identify this figure, this
9 dash 1 or dash 2?

10 WITNESS CARDONE: It is dash two.

11 MR. CHANDLER: Mr. Chairman, perhaps, if the
12 parties don't object, I can provide a copy for the reporter
13 to be included in the transcript.

14 It may be helpful. It certainly carries no
15 evidentiary weight.

16 JUDGE KELLEY: Sure.

17 MR. CHANDLER: But it may ease our reference.

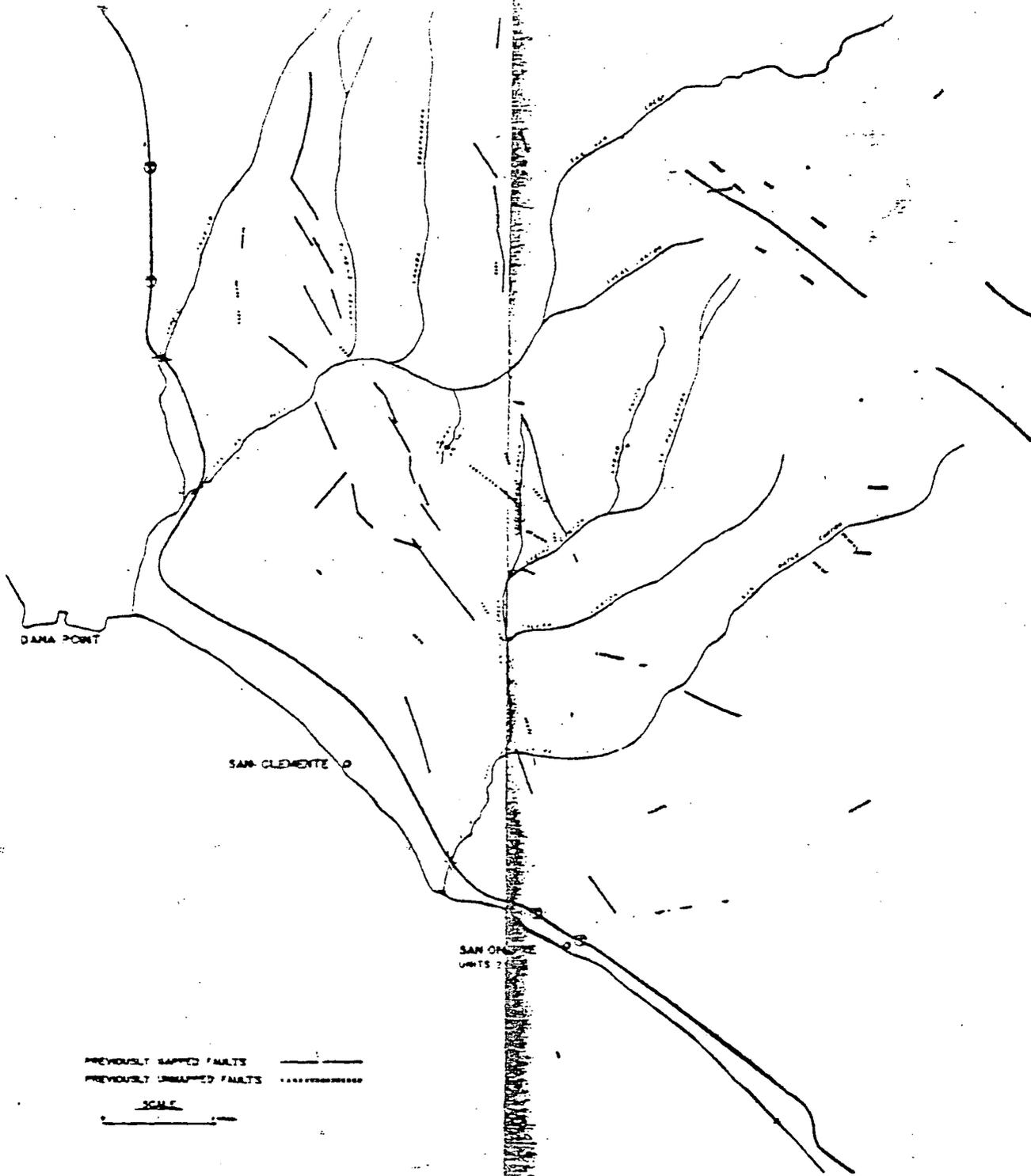
18 JUDGE KELLEY: Yes, please do.

19 MR. PIGOTT: I have no problem. I believe the
20 figures indicate that it is filed as a part of the FSAR, is
21 it not, Mr. Cardone?

22 JUDGE KELLEY: Yes. So it would seem, 361.

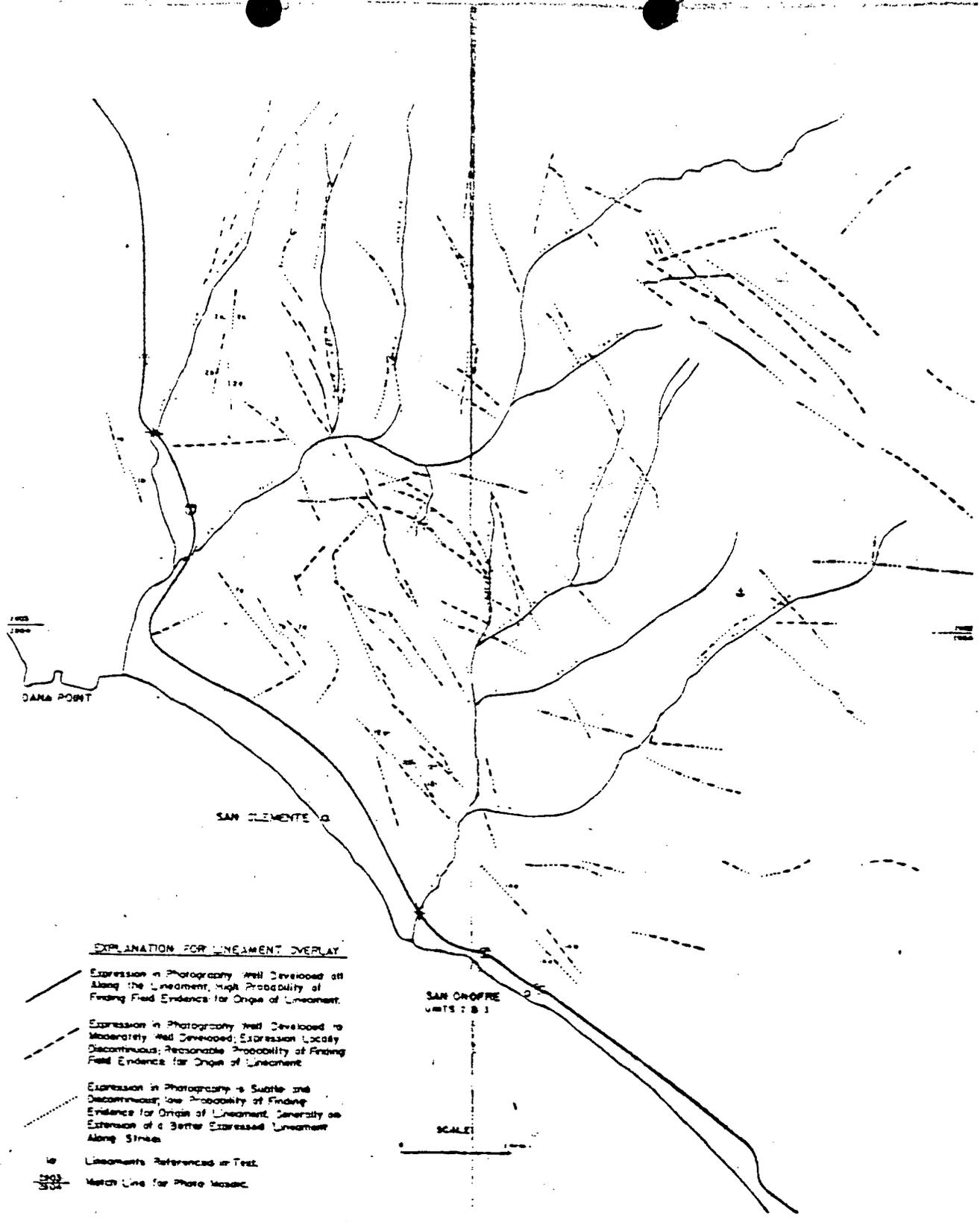
23 WITNESS CARDONE: The number is 361.27-2.

24 (Whereupon, figure 361.27-2 was bound into the
25 transcript.)



PREVIOUSLY MAPPED FAULTS —————
 PREVIOUSLY UNMAPPED FAULTS - - - - -
 SCALE
 0 1 2

SAN ONOFRE NUCLEAR GENERATING STATION Units 2 & 3
FAULT MAP
Figure 361.27-1



EXPLANATION FOR LINEAMENT OVERLAY

- Expression in Photography Well Developed all Along the Lineament, High Probability of Finding Field Evidence for Origin of Lineament.
- - - Expression in Photography Well Developed to Moderately Well Developed; Expression Locally Discontinuous; Reasonable Probability of Finding Field Evidence for Origin of Lineament.
- · · Expression in Photography is Subtle and Discontinuous; Low Probability of Finding Evidence for Origin of Lineament. Generally an Extension of a Better Expressed Lineament Along Stream.
- ⊗ Lineaments Referenced in Text.
- +— Match Line for Photo Mosaic.

SAN ONOFRE
UNITS 2 & 3

SCALE

<p>SAN ONOFRE NUCLEAR GENERATING STATION Units 2 & 3</p>
<p>LINEAMENT INTERPRETATION</p>
<p>Figure 361.27-2</p>

1 JUDGE KELLEY: Right.

2 MR. PIGOTT: Which would indicate an answer to an
3 NRC Staff question.

4 WITNESS CARDONE: Correct.

5 MR. PIGOTT: Which are a part of the FSAR.

6 WITNESS CARDONE: May I go on?

7 JUDGE KELLEY: Yes, do.

8 WITNESS CARDONE: And the lineaments that
9 appear here were checked to determine their origin, and it
10 was found that on figure 361.27-1, that pretty much the
11 Cristianitos remains, the Cristianitos fault remains as the
12 structure observed in the lineament, the -- lineaments.

13 So, the point being, after all this, that there
14 is no indication of any lineations which could trend along
15 either the San Onofre Mountain fault or the Horno Summit
16 fault, which is an indication of either -- well,
17 discontinuous faulting, no prominent faulting, and/or old
18 faulting.

19 In addition, there were -- the geophysical
20 evidence in this area indicates there is no faulting to
21 coincide with any of these features postulated by Mr. Phifer.
22 There is no geomorphic evidence of faulting in this -- these
23 areas, except the Horno Canyon fault, there is drainage
24 along that projection, but nothing to indicate recency or
25 prominence of the Horno Summit trend.

1 Lastly, the Horne Summit, if it were, let us say,
2 a fault zone, is at its closest point five miles from the site,
3 and the OZD, as you recall, is also five miles from the site,
4 so there is no doubt that the prominent fault, the controlling
5 fault, would be the OZD.

6 So, to conclude, I don't see anything in Mr.
7 Phifer's postulated faults or presentation that poses a hazard
8 to the site.

9 JUDGE KELLEY: Thank you, Mr. Cardone. Could I
10 ask you a couple of questions.

11 I gather you have reviewed the Applicants'
12 document of July 29, 1981?

13 WITNESS CARDONE: Yes.

14 JUDGE KELLEY: Right. Do you substantially
15 agree with the conclusions reached by the Applicant?

16 WITNESS CARDONE: Yes.

17 JUDGE KELLEY: Do you disagree in any significant
18 respect?

19 WITNESS CARDONE: No, I don't.

20 JUDGE KELLEY: Could you summarize -- you
21 referred to a field trip, but could you summarize the extent
22 of the Staff review? I believe there were several such trips,
23 as to just what has been involved in your reaching these
24 conclusions?

25 WITNESS CARDONE: Well, on the first day, we

75-4

1 stopped, there were about ten stops made in this system of
2 faulting, and on that same day, I was able to satisfy myself
3 that the Horno Canyon fault, assuming it is continuous, is an
4 old fault, a non-capable fault.

5 I satisfied myself that the Piedra De Lumbre is
6 not a fault, at least in the -- this lower portion. I
7 determined that there was a need to look further at the
8 Horno Summit fault, and also, I was able to dismiss the San
9 Onofre Mountain fault on that first field day.

10 JUDGE KELLEY: Did Mr. Phifer accompany the
11 group?

12 WITNESS CARDONE: Yes. Yes, Mr. Phifer was there
13 on both field trips --

14 JUDGE KELLEY: And there was an opportunity for
15 interchange among those in the group?

16 WITNESS CARDONE: Yes.

17 JUDGE KELLEY: Thank you. Were there other field
18 trips? I was under the impression that there were, but
19 perhaps it was just by the Applicants.

20 WITNESS CARDONE: The Applicant, I am sure, made
21 several.

22 JUDGE KELLEY: Yes. All right.

23 BY MR. CHANDLER:

24 Q Mr. Cardone, you made how many?

25 A (WITNESS CARDONE) Two.

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JUDGE KELLEY: Go ahead, were you going to comment on the second trip? You spoke of the first. You don't need to, but --

WITNESS CARDONE: I don't have to.

JUDGE KELLEY: All right, fine. All right, I don't --

MR. WHARTON: Yeah, I am not going to cross-examine. Just one very brief question, a small point.

CROSS-EXAMINATION

BY MR. WHARTON:

Q You did mention a standstone bed which was undisturbed, but you didn't give any indication of the age or age dating of what that would indicate.

A (WITNESS CARDONE) Well, it projects under some Eocene beds, so it would be Eocene or older, which would be tens of millions of years.

JUDGE KELLEY: Thank you very much, Mr. Cardone.

MR. CHANDLER: Thank you, Mr. Cardone.

At this time, I guess, I guess, Mr. Chairman, the next order is to have Mr. Cardone return to the stand for --

JUDGE KELLEY: Can I just ask a question or two and make a comment? I want to -- I don't remember whether we put this on the record, there was an indication earlier you might call Mr. Phifer as a witness, and I believe you decided