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NUCLEAR REGULATORY COMMISSION

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IN THE MATTER OF:

PACIFIC GAS & ELECTRIC COMPANY

(Diablo Canyon Units 1 and 2)

Docket Nos. 50-275
50-323

Place - Avila Beach, California

Date - 11 December 1978 Pages 4363 - 5101

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NUCLEAR REGULATORY COMMISSION

In the Matter of:	:	
PACIFIC GAS & ELECTRIC COMPANY	:	Docket Nos. 50-275 50-323
(Diablo Canyon Units 1 and 2)	:	

Cavalier Room,
San Luis Bay Inn,
Avila Beach, California.

Monday, December 11, 1978.

The hearing in the above-entitled matter was reconvened, pursuant to adjournment, at 8:30 a.m.

BEFORE:

ELIZABETH BOWERS, Esq., Chairman,
Atomic Safety and Licensing Board.

DR. WILLIAM E. MARTIN, Member.

GLENN O. BRIGHT, Member.

APPEARANCES:

On behalf of Applicant, Pacific Gas & Electric Company:

BRUCE NORTON, Esq., 3216 No. Third Street,
Phoenix, Arizona 85012.

MALCOLM H. FURBUSH, Esq., and PHILIP CRANE, Esq.,
Legal Department, Pacific Gas & Electric Company,
77 Beale Street, San Francisco, California 94106.

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On behalf of the Joint Intervenors:

DAVID S. FLEISCHAKER, Esq., Suite 602, 1025 15th Street, N.W., Washington, D. C.

STEPHEN KRISTOVICH, Esq., Center for Law in the Public Interest, 10203 Santa Monica Boulevard, Los Angeles, California 90067.

On behalf of the Regulatory Staff:

MARC SWANBERG, Esq. and EDWARD KETCHEN, Esq., Office of Executive Legal Director, U. S. Nuclear Regulatory Commission, Washington, D. C. 20555.

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C O N T E N T S

CONTENTS (Continued)

NOTE: Color reproduction of slides will be available in the NRC Docket Room

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P R O C E E D I N G S

MRS. BOWERS: We'd like to begin.

Now, we expect today to move right along because of two things: one, you had a vacation over the weekend and two, you did a lot of work over the weekend. So we are all prepared and ready to go.

I might also remind you -- and I keep forgetting about it -- as far as I know we are being broadcast on radio, the entire thing. It isn't a regular commercial station, it's a public interest station, or whatever they call it.

Mr. Fleischaker, are you ready?

MR. KETCHEN: Mrs. Bowers, may I have a moment?

MRS. BOWERS: Surely.

MR. KETCHEN: I would like to acknowledge that Mrs. Nadine Sides of our able support staff has joined us at counsel table and will be with us throughout the week.

MRS. BOWERS: And I'd like to announce that our secretaries are very unhappy because they know Staff secretaries come and they don't.

(Laughter.)

MR. NORTON: Mrs. Bowers, again before we start, as you'll recall during Dr. Jahns' presentation slides were used, and there was some confusion on the record for a future reader as to which slide represented which figure.

We have that information available if you'd like

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it read into the record, or how would you like to handle it?

MRS. BOWERS: If you'll just read it into the record?

MR. HORTON: All right.

On transcript page 4395, the first slide was shown, and it is the same as Figure 2 of Jahns' testimony.

At transcript page 4401, Slide 2 was shown. It is the same as Figure 5 of Jahns' testimony.

At transcript page 4402, Slide Number 3 is the same as Figure Number 8 from the Jahns' testimony.

Page 4408, Slide Number 4, and that was the slide which was not in the Jahns' testimony and it was eventually marked as Applicant's Exhibit Number 8 and admitted into evidence.

Page 4410, the fifth slide was shown, the same as Jahns' testimony Figure Number 6.

At page 4412 we saw Slide Number 6, which was the same as Figure Number 20 from Jahns' testimony.

At page 4412, again the seventh slide was shown, and it's the same as Figure Number 29 from the Jahns' testimony.

Last, page 4413, the eighth slide was shown, and it was the same as Figure Number 11 from Jahns' testimony.

MRS. BOWERS: Thank you.

Mr. Bloom, do you think there would be a special

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notation on the index page of today's transcript to point this out?

MR. FLEISCHAKER: Mrs. Bowers, I also have one preliminary matter.

We submitted Attachments A through I to accompany the argument on exceptional circumstances on our request to subpoena Drs. Luco and Trifunac. I have one additional attachment which I'd like to submit for the record which is another publication by Trifunac and Anderson. This one in fact was referred to and summarized I believe in Dr. Trifunac's letter to Dr. Siess dated June 1978, Attachment F. There are some summary pages and some tables and some graphs.

I have the entire report here which I have obtained and so I would like to submit that for the record.

MRS. BOWERS: Mr. Norton.

MR. NORTON: I'm not sure whether this was a submission to the ACRS or not, or what it was.

MR. FLEISCHAKER: This is entitled "A Report to the Advisory Committee on REactor Safeguards, U. S. Nuclear Regulatory Commission, December 30, 1976."

MR. NORTON: Dealing with Diablo Canyon?

MR. FLEISCHAKER: That's correct.

MR. NORTON: We have no objection.

MRS. BOWERS: And the Staff?

MR. KETCHEN: No objection.

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MRS. BOWERS: Do you have copies?

MR. FLEISCHAKER: Yes, Ma'am.

MRS. BOWERS: Well, we will simply make it an addition to the Board's Exhibit Number 2, so it would be "J."

(Whereupon, the document referred to was marked as Board Exhibit 2-J received in evidence.)

MRS. BOWERS: To make sure the record is clear, the document entitled "Uniform Risk - Absolute Acceleration Spectra for the Diablo Canyon Site, California," by J. G. Anderson and N. D. Trifunac has been admitted into evidence as Board Exhibit Number 2-J.

Are you ready, Mr. Fleischaker?

MR. FLEISCHAKER: Yes, Ma'am, I'm ready.

Whereupon,

RICHARD H.JAHNS,

DOUGLAS H. HAMILTON,

and

C. RICHARD WILLINGHAM

resumed the stand on behalf of the Applicant and, having been previously duly sworn, were examined and testified further as follows:

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CROSS-EXAMINATION (Continued)

BY MR. FLEISCHAKER:

Q Dr. Jahns, I would like please to begin where we left off at the end of the session on Friday. We were talking about the length of the Hosgri Fault, the Fault Zone, and I believe your testimony is that it's 145 or approximately 145 kilometers in length.

At the end of the session you identified for us on one of the figures the Hosgri Fault.

In your testimony in the transcript you indicate by -- you state that you have identified the length of the criteria -- excuse me, the length of the Hosgri by criteria usually applied by geologists, and I was wondering if you would identify those criteria.

A (Witness Jahns) Well, the most fundamental criterion of all is whether or not a rupture is present. And if a fault dies out, it normally does so in ground that is essentially unbroken as contrasted with the ground traversed by the fault.

Q Could you be more specific in indicating what you mean by a fault dying out, specifically with respect to the Hosgri?

A Well, let's examine it in the general case first.

If we're dealing with a fault that is being traced through a given crustal domain, we recognize it as a

eb5

fault by means of a large variety of possible criteria, all of which are to the general effect of whether a rupture has occurred and whether there has been differential displacement along that rupture.

As we trace the fault in a regional sense now, we may well discover evidence suggesting a diminution of offset along the fault or the fault zone itself may become narrower or the surface expression of the fault may become fainter or smaller. And normally an experienced geologist recognizes the sum total or the total impact of such criteria and begins to develop the notion that the fault is dying out.

Well, it's rather difficult to tell exactly where a large fault dies out, so that what a geologist is normally looking for is not the piece of unbroken ground but instead, the logical end stage of the sum of the features he has been looking at. Thus, it's rather common that a geologist reports a fault as dying out into a series of folds or splaying out into a horsetail of smaller breaks; this sort of thing. That is normally what happens.

Q How does the Hosgri then terminate or, to use your terminology, die out at its northern extent?

A Well, so far as I'm aware, and this is not direct because I haven't personally examined the records -- I think Mr. Hamilton can probably speak more to that in a direct sense -- but in that direction it does die out into other

eb7

structural features. It dies out into less sharply disturbed but nonetheless disturbed ground.

Q Mr. Hamilton, what happens to the Hosgri at the northern extent?

A (Witness Hamilton) The Hosgri has been mapped of course by seismic reflection techniques, and the mapping shows that the Hosgri is a very well-defined feature around the latitude of Estero Bay. There is substantial vertical displacement in the younger Tertiary section on the west side of it.

As the fault is traced northward, it begins to develop additional branches that are subparallel to the main branch and about the latitude of Cambria, several kilometers north of the north end of Estero Bay, the fault begins to veer toward a more westerly strike.

In that area, the actual offset that can be discerned from the seismic reflection records across the fault begins to diminish and the fault breaks become accompanied by more pronounced folding than lies in the ground, especially on either side of the fault.

As the fault is gtraced farther northward it swings out and it becomes localized on the southwesterly flank of the large upwarp fold which we have assigned the name the Piedras Blancas antiform, which is a term indicating a complex, large, upfolded structure that is the structural

eb8

expression of the on-land area between San Simeon and Ragged Point.

This large fold extends out to sea in a northwesterly direction from the Piedras Blancas region onshore, and the Hosgri Fault is traced around its southwesterly flank and it passes around its nose north of the Piedras Blancas area. And there, the last expression that we see of it is some relatively small-scale faulting along the westerly side of this fold structure. That seems to pass into ground that we do not detect faulting in farther north.

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Q Dr. Jahns, let me go to the other end. How does the Hosgri Fault die out on the -- or terminate on the southern end?

A (Witness Jahns) Also into ground within the transition zone between the Transverse Ranges and Coast Range Provinces, as discussed earlier and also into domains of otherwise disturbed ground.

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MR. FLEISCHAKER: Mrs. Bowers, could I have one moment? Mr. Hubbard isn't here and he has a reference that I'm going to see if I can get from the Staff.

(Pause.)

BY MR. FLEISCHAKER:

Q Mr. Hamilton, what is the data -- Strike that.

What is your interpretation as to what happens to the Hosgri at the southern extent?

A (Witness Hamilton) Well the Hosgri in its southerly reach, as in its northerly, is mapped by seismic reflection techniques, chiefly. And we find that it can be followed as a very well defined fault structure to a latitude a bit south of that of Point Sal. There we find that the fault becomes mixed in with the zone that encompasses many rather high amplitude folds and within which we can identify other greater or less prominent faults.

And we are last able to trace the Hosgri Fault as a discrete break somewhere between the latitude of Point Sal

agb2

and Purisima Point. In that region, we feel that the amount of lateral strain and vertical strain that is represented by distinct offset along the fault farther north is both dying out southward and becomes distributed among the larger amplitude folds that we see in that area.

And some of the movement that has existed in the geologic past is probably transferred to other faults such as the Lions Head Fault and perhaps on to isolated breaks within the ground in the region of the southerly end of the Hosgri.

Q Dr. Jahns, in your testimony, I think on Thursday, you indicated that a 7.5 magnitude would be an extremely conservative estimate of the maximum earthquake potential, and that a 6.5 to 7 magnitude would be very large, I think those were the words that you used.

Do you have an opinion as to the maximum earthquake potential of the Hosgri?

A (Witness Jahns) Yes, I do.

Q What is that opinion?

A Magnitude 6.5.

Q Now, upon what is that based?

A That's based on an assemblage of factors, principally four.

Q What are those four?

A First would be fault length. Second would be the

agb3

absence of a continuous Holocene surface trace of the fault. In other words, the absence of expression at the present surface that one normally associates with faults capable of larger earthquakes.

Third would be the constraints on cumulative offset along the fault during the last five million years. Fourth is the general situation of the Hosgri in the tectonic framework of the region.

And to translate that into the tectonic bottom line, so to speak, it's fairly plain that the great bulk of interplate movement between the Pacific and American Plates during the last five million years has occurred along the San Andreas Fault.

Q I would like to focus on Number One.

In what way did you consider fault length in reaching your conclusion?

A I'm not sure I understand what you mean in what way?

Q How did you factor the length of the fault into your conclusion regarding the maximum magnitude?

A Oh, I see what you mean.

The fault length in the first place can be compared in a very simple way with the lengths of other faults that we can regard as active or potentially active in California and Western Nevada and can be one of several parameters

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that we can compare in terms of, let's say, potential for generating an earthquake.

So we can compare the 145 kilometer length of the Hosgri Fault, for example, with the 1000-plus kilometer length of this San Andreas.

Now there is both an empirical relationship and there is a series of, let's say, mechanistic reasons for correlating at least approximately the length of a fault with its capacity, let's say, for generating a major earthquake.

And it is true that empirically there is a broad relationship so that it is unrealistic to expect an earthquake larger than a given level from a fault of a given length.

More than that for strike-slip faults in this part of the world, it is customary conservatively to assume that in a given maximum credible event, approximately one-half of the total length of the fault will experience rupture.

The reason for this assumption is that rupture length is normally more directly correlated with earthquake magnitude.

Q Were there any specific correlations upon which you relied or to which you referred?

A No, nothing specific. This -- I think it is more accurate to say that this reflects a sum-total approach, using as many reliable data as are available. In other words, part of the general approach involved in ordering the

agb5

various faults within the tectonic framework.

Q Did you consider any of these correlations in general way?

In other words, you've made reference to correlations, and what I'm wondering, is this work that you yourself -- Strike that. Are these correlations something that you, yourself, have performed?

A Yes, that's correct. Although by no means could I claim to have originated the basic data. The record is replete with basic information required for these correlations.

This is not to say that all the information one would want for the correlations is at hand. Far from it. But, what one does is examine each of the major faults or each of the faults of interest and examine them in terms of all parameters for which there is information.

Then one looks at this matrix, so to speak, and attempts to order these faults in terms of their general dimensions, their characteristics and their behavior through time in order really to see what's been happening.

And then it is of interest to compare the results of that with the results of other kinds of analyses aimed at determining what's been happening relative to the plate boundary and to interplate movement.

Q These correlations that you've done, have you

agb6

published those anywhere?

A Yes, some of those have been published, particularly in connection with the Transverse Ranges Province and its tectonics.

Q Have you published any correlations that relate to strike-slip faults?

A Yes.

Q The length of magnitude?

A Yes.

Q Would those be cited in your curriculum vitae?

A I'm not sure, because the principal comparisons that were made involved the San Andreas, the Newport-Endelwood, the Elsinore and some other fault zones in the context of appraising offshore relationships south of the latitude of Los Angeles. And that report, a multi-author report, is in the public domain. It is a publication, but I don't recall whether it has been cited in the list you refer to.

Q Now, on Friday we discussed generally one such correlation of Buchanan-Banks, and you indicated you had not relied on that.

Are there others that have been published in the literature upon which you relied in reaching conclusions regarding the maximum earthquake potential of this 145 kilometer fault?

A Other correlations of what kind?

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Q Between fault length and magnitude on strike-slip faults?

MR. NORTON: Excuse me, Mrs. Bowers. I would raise a very slight objection, if you will.

I think Dr. Jahns has testified that -- I think he used the term, "the sum total of experience," and so on in factoring this in, and so I would only ask Mr. Fleischaker to phrase his question in terms of specifically relied on or is he talking about things that he's read over the course of years, that the knowledge is in his head but was not specifically relied on or looked at for this problem.

MRS. BOWERS: Well, Mr. Fleischaker, the direct testimony contains literature references at the back that are acknowledged as being relied upon.

Isn't that correct, Dr. Jahns?

WITNESS JAHNS: Yes, that's correct.

MRS. BOWERS: There may be others.

MR. FLEISCHAKER: Well I haven't read each and every one of those. And, what I'm trying to determine, if I understand Dr. Jahns testimony, it is that he has relied generally on correlations between fault length and magnitude on strike-slip faults, and I'm trying to determine whether there are specific correlations upon which he relied.

We have determined he did not rely on Buchanan and Banks and that he has relied on some of his and I want

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to see if there are other literature that he specifically consulted.

MRS. BOWERS: We'd like the question to be answered.

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WITNESS JAHNS: Well, Mr. Fleischaker, there are two kinds of references in the literature that one can consult in connection with this sort of work. One is relatively specific, ordinarily addressed to one fault or a group of closely related faults, and that provides what we might call basic data. Typically this would represent a study of an area of a given fault in which study the investigator has reached some conclusions concerning dimensional characteristics or behavior or something of that sort relative to the fault.

Now the other type of reference is the Buchanan-Banks type, or the Smith-Albee type, or any of several others that reflect fundamentally compilations of available information. The plotting of these data to show the distribution curves, this kind of thing.

And when I indicated I did not depend on the latter type, it doesn't mean I didn't look at them. But for correlations of this sort I wanted to examine not only these, but all other parameters that might be pertinent, and I wanted to begin at the beginning, so to speak. So I relied more on the other type of reference.

BY MR. FLEISCHAKER:

Q Let me address, then, each one of those, just to make clear:

Did you specifically refer to the Buchanan-Banks

mpb2

in drawing the conclusions about the magnitude earthquakes that one would expect on the Hosgri?

A (Witness Jahns) No.

Q Okay.

Was there any other publication, specific publication to which you referred of this second type in drawing your conclusions regarding the magnitude?

A Yes.

For example, the existing earthquake catalogs represent first sources in effect for the information on the earthquakes.

Q Excuse me, I think we're passing like ships.

I understood that there were correlations of a general nature between fault length and magnitude other than Buchanan-Banks, and my question was:

Did you rely on any of those in drawing your conclusions?

A I'm sorry, I transposed the two classes.

No.

Q Okay.

So there were none of this second class, that is the general correlations, that you relied upon?

A That's correct, none that I relied upon.

Q Okay.

Now with respect to the first class, what were

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the references that you relied upon to draw conclusions that permitted you to correlate the fault length and the maximum magnitude on this fault?

A Well, these are, first, the record of the earthquakes themselves which are published in numerous catalogs. And for the other end of the input, a series of published papers and especially of published maps.

And what one does these days ordinarily is to start with the latest edition of some State of California map because the State has published some excellent compilations that are of particular pertinence to faults and earthquakes.

Q I'd like to go back to the correlations which you, yourself, have done, and upon which you have relied.

Are these the correlations that pertain to particular regions, studies of particular fault lengths in particular regions?

A Yes, in general they apply to the California-Western Nevada region.

Q Did you do any of these studies specifically on Coastal Ranges strike-slip faults?

A Well, the studies included faults of that kind, yes.

Q So you have examined the Coastal Ranges strike-slip faults and done correlations between fault lengths and

mpb4

magnitudes, is that correct?

A Here I'm not certain of what you mean by "I have examined these faults". Do you mean in the literature or examined them, walking them out in the field, for example?

Q No.

I mean have you yourself done a correlation, some regression analysis or mathematical correlation where the subject was Coastal Range strike-slip faults, and the purpose of the correlation was to -- or the purpose of the study was to derive some correlation between fault length and magnitude?

A Yes, I have.

Q Which faults were they, sir?

A This includes a good many of the ones we mentioned in last week's testimony.

Would you like some specific examples?

Q No.

Did these all fall in the Transverse Range, or were there some without the Transverse Range?

A No, these are Coast Range features.

Q I have a couple of questions about this.

For a magnitude 6.5 earthquake, what length of fault would we on average expect to see generated? Do you recall that from your studies?

A Now your question is a very difficult one to

mpb5

answer specifically because it contains a built-in ambiguity.

First I have to ask what you mean by "expect"? Are you correlating that with maximum expectable event, or would I expect some value as a maximum credible value?

This is not splitting hairs. This is a non-trivial matter.

Q I'll be specific.

Specifically in your correlations were these -- did you do in your correlations a regression analysis between earthquakes' lengths, size, and expected magnitude?

A No, I did not, because I am convinced that regression analyses, although very interesting, represent a procedural step that extends beyond the value of many of our basic data.

Q Okay.

How did you do your correlation -- or how did you do your analysis, then?

A I prefer to plot these up, and by inspection examine them, and then ask what they mean.

Typically a plot will appear as a kind of cumulus cloud of points, given enough data for information, and then perhaps there will be one point that's way off to one side. And this is typically one of the things that a geologist looks for. He sees a point off to one side and it raises immediately a question. Is this a sport of some kind? Why

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is it exceptional? And it's this kind of a relationship that is a red flag or a tip-off that there is some factor in the situation that wasn't considered previously, and, hence, it often offers insight as to possible alternative courses of investigation.

That's the kind of examination I've done principally.

Q How did you state your conclusions? What terms did you use to state your conclusions?

A Relative to what matter?

Q The expected earthquake that you could get.

I don't understand the terminology that you used, and I'm trying to understand what came out, what was the output from this examination?

A Normally if I happen to be focused on the question of size of the earthquake that one might associate with a given fault, than the data permitting, I try to look at it in terms of maximum expectable event and maximum credible event.

Q Okay.

A And these are roughly correlative with other two-ply terminology.

Q Is the maximum expectable something that generally approximates a mean? An "on average", is that what we mean by that?

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A Not really.

For most faults for which we have a reasonable amount of information, the tendency is to examine the largest historical event and then to assume for geologic analyses that the maximum expectable event will be somewhat higher than that. And that just represents a summary conclusion on the historic record.

And then the maximum credible is something beyond that.

Q When you say "maximum expectable", do you put some time parameter on that; "maximum expectable" within a time frame, 100 years, 1000 years?

A Only when it's appropriate to do so, as when one is considering an engineering project, a big dam or something of this sort.

Q Now with respect to the examinations, the analysis that you performed on the Coastal strike-slip faults, what is the -- if you look -- let me ask you this question:

Can you run your analysis the other way? That is, can you look at a 6.5 magnitude and say the range of faulting we would expect to see is such-and-such? Have you done that kind of analysis?

A Yes. You can start on either the vertical or the horizontal limb of the graph. But when you do this and compare the two results you get into this major area of

mph8

ambiguity that I mentioned last week. It's a result of the spread of the basic data.

Q Okay.

Then let me see if I can get your understanding of that spread.

For a 6.5 magnitude event, what kinds of faults -- what range of fault lengths would we see in the Coastal Range for strike-slip faults?

A For a 6.5 magnitude? I would prefer to answer that for strike-slip faults in California in general, because the data are pretty skimpy for the Coast Ranges faults in the area that you're referring to.

So for a magnitude 6.5, we're really talking about structure lengths on the order of 50 or 60 kilometers, this kind of thing.

Q What is the spread?

A The spread is greater than that. I don't recall exactly what it is in plots.

Q Do you have any sense of -- this 50 or 60 I guess would be somewhat of a mean.

A That would represent the major concentration also.

Q Do you have a general sense of the standard deviation going both ways?

A No. I frankly never have calculated that.

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Q How about for a magnitude 7 earthquake?

A A magnitude seven would be corresponding to a substantially greater rupture length.

Q And what would that be?

C4

A Magnitude 7 would be up in the -- and this is only a guesstimate based on memory -- would be up in the range of 75 to 90 kilometers, this kind of thing.

Q And that represents a mean value, again?

A It represents a major concentration of values on a plot.

I hesitate to talk about means and standard deviations because the data really are skimpy and the plots represent a very considerable spread. I think we have to keep this in mind when we talk about these correlations.

Q Okay, I understand.

Let me see if I can ask the question a different way.

Can you reach back into your memory and, for a 6.5, recall a shorter kind of fault and a longer fault from your experience in examining the data? Can you recall specific examples of very short faults and specific examples of longer faults?

MR. MORTON: Excuse me, Mrs. Bowers.

Is this question limited to the Coastal Ranges or is this the State of California, including the Transverse

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Range?

MR. FLEISCHAKER: My recollection was that Dr. Jahns is talking about the entire state, he thought that was the most useful, and I'm prepared to accept that.

MRS. BOWERS: I think he even brought in Nevada, Western Nevada.

WITNESS JAHNS: That's correct.

MRS. BOWERS: Okay.

WITNESS JAHNS: Now, before we can respond to that, it becomes necessary to divide up the faults into three general kinds: the strike-slip that we've been talking about mostly this morning, the dip-slip thrust faults and the dip-slip normal faults.

BY MR. FLEISCHAKER:

Q I'd like to limit our considerations to strike-slip.

A (Witness Jahns) Okay.

If we do that, we pretty much eliminate, I won't say a major class, but a class of faults for which there is a paramount of evidence linking a given magnitude with a relatively shorter rupture length. That seems to be a characteristic of the thrust faults. And of the normal faults as well.

But for strike-slip faults, the rupture length is greater, in general, for a given magnitude event.

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Q Can you think of a -- again, going back to the first question, can you think -- do you have in mind a shorter kind of strike-slip and a longer kind of strike-slip for the 6.5 magnitude?

A Not particularly.

Q Okay.

How about magnitude 7?

A I think I'd have to give the same answer to that. I haven't thought much about that.

Q Okay.

Let me ask then for 7.5, where does the data cluster in terms of length for strike-slip faults?

A 7.5?

Q Correct.

A I had better not offer you an answer to that. I would prefer to consider an 8-plus, simply because I don't recall any particular value and there would be no point in my essentially guessing on it.

Q When you gave us the value of 6.5 for a 145 kilometer fault, did that represent a maximum expectable or a maximum credible event, in your terminology?

A I have not broken it down in that way. I just thought of it in terms of a maximum event.

And I've used the word in my own mind "expected," but not correlating it with the formal maximum expectable

agb4

category.

In other words, my examination of that kind of question has been largely in a tectonic context, rather than in a context of an engineering project.

Q Thank you.

MR. FLEISCHAKER: Excuse me, I'm going to another line, but my transcript was missing over the weekend.

(Pause.)

BY MR. FLEISCHAKER:

Q When I asked you, Dr. Jahns, about the factors that you -- the basis for your conclusion that 6.5 was the magnitude that you would assign to this, you listed four things. One was fault length. The second, I believe, was the absence of a continuous Holocene trace.

Upon what are you relying to draw that conclusion?

A (Witness Jahns) In terms of all examination of the sea floor that has been made, and that includes, of course, the geophysical traverses that have been discussed earlier, there is no evidence of a continuous surface trace.

Q Let me pursue this fault length subject just a little bit further.

Going to page 4418 of the transcript of December 6, you state, after discussing fault length and the criteria, you say:

"This leads to a second conclusion

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that the Hosgri and the San Simeon Faults are not connected, certainly not at any present levels of exposure on the sea floor."

I will ask either you, or perhaps Mr. Hamilton might be a more appropriate person, about the data.

Can we turn, for purposes of references, to Figure 44 in the testimony.

Now this figure, the drawing here is consistent with the previous description by the witnesses showing the Hosgri swinging out to the left offshore, hugging the shoreline south of the onland exposures there.

What seismic reflection data is there south of San Simeon and offshore just near the shoreline there?

A I think a response from Mr. Hamilton would be more appropriate.

Q Okay.

4.095

A (Witness Hamilton) In the reach of the offshore area that extends into the near shore region just south of San Simeon and extending for several miles south of there, we had a few lines, I think not more than two or three, which penetrated essentially in a gross way to about where the dashed line can be seen on Figure 44, representing the extension of the San Simeon Fault projected southeast from its onshore exposure.

These were seismic reflection lines run by,

agb6

I believe, both the Aquatronics firm under contract to PG&E and I think that possibly one or so of the lines run by the KELEZ ship for the U.S. Geological Survey ran into that area also.

Q So that there is some data in this new shore region that permits you to -- from which you can interpret the existence of faulting in that reach, is that correct?

A That's correct.

And let me add a bit to say that there are a fair number of lines that extend into the region going on south between there and Estero Bay. I'm speaking only of the nearest lines that came inshore.

But the trace that is described for the Hosgri Fault in that area between Point Estero, let's say, and points northerly are crossed by quite a number of lines

Q Mr. Hamilton, you must be familiar with the map, the new map that -- the USGS map that Holly Wagner and Dave McCullough were part of the authors of and I think it is 517, which is of Southern California and depicts in part the results from the seismic reflection survey. Have you seen that map?

A I think I would want to see a copy of the map before relying solely on my memory to comment on it.

Q We've had it here every day but today. But perhaps if I give you a precise citation to it then that might permit

agb7

you to comment.

The name of this map -- and I'm sorry we don't have it here today, but in view of the hassle we had on maps on Friday, I was a little bit reluctant.

In any case, this map has the following citation: Buchanan-Banks, Pampeyan , Wagner and McCulloch, 1978, Preliminary Map Showing Recency of Faulting in the Coastal South Central California, U.S.G.S. Miscellaneous Field Map, Map MF-910, three maps at one to 250,000.

A I'm familiar with that.

Are you in some way correlating that with something called 517?

Q I was mistaken in my initial citation.

MRS. BOWERS: Do you have a copy of it here? Is there a copy in the room?

WITNESS HAMILTON: I have a copy of the map. At least it's a Xerox copy.

BY MR. FLEISCHAKER:

Q You're familiar with that map?

A (Witness Hamilton) I've examined it, yes.

Q There is an area on that map, is there not, underneath the San Simeon shoreline where they have inscribed the words, "No data?"

A To my recollection, this is such a notation. I've always been puzzled by it, in fact. There are several

agb8

areas on that map where the annotation, "No data" is present and those lie in areas where data is present. That's why I'm puzzled by them.

MR. NORTON: Mrs. Bowers, we are once again getting into discussions of exhibits that are not here, are not marked into evidence, and they may become, on top of that, they become hearsay.

Evidently there is a spot marked, "No data" on someone else's map, and Mr. Hamilton is testifying that there is data. It's hearsay as to the fact that there is no data. We don't know why the maker of the map put, "No data" there. Maybe whoever it was just didn't have the data available to them or didn't know it existed or what have you.

And yet there are implications from these kind of questions that can be drawn, and I think it is improperly so, because there's no foundation for that. There is not even an exhibit here to be discussing this map.

MR. FLEISCHAKER: Let me see if I can respond to that.

There is, first of all, a foundation because I asked Mr. Hamilton about his map and asked him to describe for me what data existed of the points south of San Simeon.

The USGS apparently will be on the stand later in this proceeding, and it was at that time that I intended to question them about the map that they apparently authored,

agb9

And I am trying to determine whether Mr. Hamilton's understanding of the data base is the same apparently as the USGS people.

If there is some discrepancy, certainly the Applicant will have the opportunity on its rebuttal case to put Mr. Hamilton on to ressond to the USGS people.

MRS. BOWERS: Mr. Ketchen, does the Staff have a position on this matter?

MR. KETCHEN: I believe our position is this. We would rather stay out of this argument. I think our position is if Mr. Fleischaker properly presents the information to the witness and asks a question on a proper map and the witness can indicate that he has an opinion on that or he doesn't have an opinion, then that would be the answer. He may have answered the question already.

And that's about all I think I could add to the discussion, he is an expert and I think could offer his opinion, if the question is properly put to him.

MR. FLEISCHAKER: Mrs. Bowers, let me see, we have a copy of this map but we have it mounted on a large board. Now, I'll be happy to mark it as an exhibit and we can use this map for convenience to permit Mr. Hamilton to examine it. And then I can mark my map as an exhibit and offer to introduce it into evidence, if Mr. Norton will permit that, if he has not objection to that.

I have no objection to marking the one that we

agbl0

have mounted and leaving it as an exhibit in this proceeding.

2c ebl

MR. NORTON: I have absolutely no objection. What I am objecting to is we are again starting to discuss things we don't have. I don't have a copy of it. I can't follow the questions. The Board doesn't have a copy of it. Mr. Fleischaker doesn't even have a copy of it, and he is going from his memory, and it's just totally improper procedure.

MR. FLEISCHAKER: Well, what I would suggest is we take perhaps the Staff's map over to Mr. Hamilton, and permit him to examine the map. And if Counsel wants to take a look at it at the same time, that might be a way to expedite this.

4.210

I will bring our large map in and mark it as an exhibit so it can be utilized throughout the proceeding if necessary.

MRS. BOWERS: Well, this is very awkward but as I mentioned one day last week, we did have similar situations come up from time to time in the environmental-issue hearing where there would be one copy of a scientific article and perhaps the witness also had a copy of the article, and there would be cross-examination on whether the witness agreed or disagreed with that article. And I cannot distinguish this really from that situation.

Of course there was a flexible accommodation at the time. This would be, too.

But let me ask you, if this is an official USGS

eb2

map, the Board could take official notice of it.

MR. FLEISCHAKER: That's correct. And I think that Mr. Norton's problem, and I think it is a good one, is that this witness hasn't got it in front of him and Counsel doesn't have it in front of him, and I think that is an adequate objection, and so I'm proposing a way to try to accommodate that.

MRS. BOWERS: But if you want to go ahead right now --

MR. FLEISCHAKER: We have a map right here.

MRS. BOWERS: -- there's one copy in the room except for maybe some sort of a reduced xerox copy.

MR. FLEISCHAKER: I don't intend to-- I think we can do this pretty quickly; if we just take this map and take it over to Mr. Hamilton, I think we can ask a few questions of him. And if we need it for after lunch for redirect I will send -- we'll go home and pick up our large cardboard copy.

The fact is we anticipated this in part by having this large map mounted, and I intended to use it in cross-examination of USGS. Also last week, because of the problems we have, I understand the need to xerox copies of articles but here we're dealing with large maps and....

DR. MARTIN: Is it one of the maps that you used in your --

eb3

MR. FLEISCHAKER: This is a different map.

DR. MARTIN: Does the question absolutely depend on the map?

MR. FLEISCHAKER: I think from Mr. Norton's point of view it does because he would like for Mr. Hamilton to look at it, and I think Mr. Norton would like to take a look at this map. That's my understanding of his position.

MRS. BOWERS: Would it be helpful to recess for a few minutes so that you can all gather around the one copy of the map?

MR. FLEISCHAKER: I think it would.

MRS. BOWERS: Well, we'll do that but we don't want you to go away. It will just be a few minutes.

(Recess.)

MRS. BOWERS: Are you ready to proceed?

MR. FLEISCHAKER: Yes, Ma'am.

BY MR. FLEISCHAKER:

Q Now, Mr. Hamilton, before the break we were discussing the 1978 map.

MRS. BOWERS: Does it have more of a date than just '78? Is there a month?

MR. FLEISCHAKER: It has a number, I think it is 917, which is sort of a shorthand way--

BY MR. FLEISCHAKER:

Q Is it 917, Mr. Hamilton?

eb4

A (Witness Hamilton) Yes. May I respond to that?

I think it is just dated 1978. I'm not aware of an official indication of a month on it. I think that these maps are released at a specific time during the year and therefore you could determine what the date of release was.

If I could go a bit further, I think this came out rather late in the year, like in October or September, but I'm not precisely sure of that. That was certainly the first that I saw of it.

Q Does this have a title at the top there, Mr. Hamilton, just for purposes of the record?

A Well, the title on the top is a more general one. It says "Miscellaneous Field Studies Map MF-910, Sheet 2 of 3."

The actual title of the map is on the bottom. Do you want me to read that?

Q Sure. Please.

A It's entitled "Preliminary Map Showing Recency of Faulting in Coastal South Central California," and then it gives the authors.

Q Okay.

For purposes of our discussion we can just refer to this as Map 910 if that's convenient.

MRS. BOWERS: I thought it was 917.

MR. FLEISCHAKER: I was wrong again. It is 910.

eb5

MRS. BOWERS: All right.

BY MR. FLEISCHAKER:

Q Are there areas on that map offshore which have the notation, "No data"?

A (Witness Hamilton) Yes, there are.

Q Those have been marked on the map, have they not, 1 through 4?

A Yes. THey have been annotated circles numbered 1, 2, 3 and 4 on the copy I'm looking at.

Q Could you give us a very quick description of where those areas are?

A Yes.

Area 1 is located in the north-trending part of the coast at the north margin of the map which geographically lies just north of Cape San Martin.

Annotated number 2-- The annotation is actually placed immediately south of Point Piedras Blancas. However, the place that says "No data" extends from the reach of the coast immediately offshore between Point Piedras Blancas and Point San Simeon and down into the reach of coast between San Simeon and Cambria.

Annotated number 3 is placed on the map just a little bit southeast of Point Estero. The annotation "No data" is actually in the northeasterly corner of Estero Bay, west of Cayucos and lying east of the annotated 3.

eb6

Annotated 4 is in the general region of the southerly part of San Luis Obispo Bay, approximately offshore from Pismo Beach and Arroyo Grande and more or less south of Avila Beach.

Q Now with respect to the area that is notated by the number 2 that is in the area south of San Simeon, if we again examine Figure 44 just for general reference, in the general area of the dotted lines representing the San Simeon FAult that comes offshore, is that generally accurate?

A. Yes, that's approximately where that "No data" annotation -- and I prefer to refer to the map statement of "No data" rather than the numbered location. That is the numbered location of the device where "No data" is, but I want to talk about where it says "No data" on the map.

Q. Do you agree with that annotation? Are you aware of data in that area?

MR. NORTON: Mrs. Bowers, we're going again to have to object because I don't know what "No data" means. I don't think there has been any foundation laid as to what "No data" means. Does that mean no USGS data, no Aquatronics data? I don't know what that means and it hasn't been established.

So when you ask him if he agrees with it, I don't know that he knows what it means. That certainly hasn't been established.

I don't know whether they know or not, but

eb7

certainly there is no foundation for that question at this moment in time.

MRS. BOWERS: Could you build a foundation? Is this typical in the scientific area that you're in?

WITNESS HAMILTON: I think I could respond to that and say that maps are sometimes constructed in a way that shows the reliability or the presence or absence of the kind of data that was used in making the map, so that some regions will be annotated as "Not mapped" or "Insufficient data base" or some kind of thing like that.

So it is not unprecedented that a particular area will be represented as having some lack of data.

In the case of map MF-910 in the offshore region particularly, there is no indication that I am aware of as to just what the data base is. For example, it does not contain a track chart and it doesn't even contain an indication of whether one kind or another kind of information-gathering technique was used.

So this appears to me to be a very generalized kind of compilation of someone's, some one of the authors', presumably, interpretation.

Maybe I could just go farther to say that I don't understand, as I said earlier, why this map says "No data" in the area where it says it near annotation 2 because the track charts that show where seismic reflection lines are in

eb8

that region show lines that do extend into the area where "No data" is annotated.

MR. NORTON: Mrs. Bowers, I think my objection is well taken. There is no foundation for those questions until we talk to the authors of the map as to what data they compiled the map from. I don't know if it's aeromagnetic, gravity, striker. I have no idea. And evidently the map doesn't -- or sparker, rather. And evidently the map doesn't have that either.

MR. FLEISCHAKER: I think the map reflects that it is seismic reflection data, and I think that Mr. Norton's objection is not well taken.

Mr. Hamilton has a different view of the data base. And while the map in itself may not be a complete -- may be ambiguous because the notations aren't sufficient, the USGS will be on the stand, as I understand it, later on and perhaps they can help us.

But in the meantime I think it is useful to have Mr. Hamilton's comments on this map.

MR. NORTON: Well, Mrs. Bowers, I would only say that it might be useful but it also might be misleading if Mr. Hamilton doesn't have the benefit of knowing what the makers of the map were using as a data base. You know, he's playing guessing games over there, not knowing-- If he's going to call USGS, fine, then he can call USGS and lay the

eb9

foundation.

MRS. BOWERS: Mr. Ketchen?

MR. KETCHEM: Mrs. Bowers, I'm not sure what the objection is to or where we are exactly. I know there's an objection but there is no question pending.

Is the objection to further questioning along this line, or is it to introduction of the document, or just what is the objection?

MR. NORTON: There was a question, Mrs. Bowers, and that was-- It was a question asking about the "No data," and I objected on the basis that there was no foundation as to what "No data" meant on that map, whether it meant that USGS hadn't run lines there, or the authors of the map didn't have them in their possession when they drew the map. I still don't know the answer to that question, of course, and Mr. Hamilton explored it and he said he doesn't know the answer either.

So to then ask him those kinds of questions about what that means, it's guesswork on his part and that's not fair to a witness to make him guess and then later put somebody on and show that his guesses were wrong.

MRS. BOWERS: Well, Mr. Norton, do you intend to recall Mr. Hamilton after the USGS witnesses testify?

MR. NORTON: I certainly had not thought about it up to this point in time, although he will be available

eb10

undoubtedly for rebuttal testimony which in time would come after the USGS witnesses.

You know, we certainly hadn't in the context of this map because we had not seen it but, you know, he'll be here; there's no question about that.

Excuse me, Mrs. Bowers, there is one other possibility of course and that is that Mr. Hamilton or Mr. Willingham or somebody might be able to call Mr. Wagner or someone like that on the phone and get an understanding as to the why-for of the "No data" on the map, and then I guess they would not be proceeding on a guesswork basis. It would be hearsay but at least hearsay by one of the authors of the map as opposed to us sitting around guessing what it means.

MR. FLEISCHAKER: Mrs. Bowers, if I can comment, I think that there is an adequate remedy here which is that if USGS takes the stand, then certainly Mr. Hamilton can come back and respond to whatever is said.

I don't think that the question is objectionable because the map is ambiguous. The remedy for that is to get USGS on the stand and have them explain the ambiguity, but I think that it's useful, since it is an official government document, to have Mr. Hamilton's reaction to it on the record and it can be explored further in the proceeding.

MRS. BOWERS: Well, but what can be accomplished

ebll

when he says he really doesn't know what they meant or why they put the notation there?

Now it seems to us that the objection should be sustained unless it can be ascertained by a phone call to get some meaning to this.

MR. FLEISCHAKER: I'm not sure I understand the basis for....

MRS. BOWERS: The witness said he doesn't understand why they put the "No data" notation there.

WITNESS HAMILTON: Could I interject a comment at this point?

One reason for my confusion is that we have a prior U. S. government release showing where the KELEZ sparker seismic reflection survey was run, which shows the lines do exist in that area, USGS lines exist in that area.

And we know also that we have a very good-quality line that was run in that area which we provided to the USGS.

MR. FLEISCHAKER: Well, it seems to me there is a conflict between his understanding of the data base and what appears on the USGS map, and that striking this testimony from this record doesn't clear up that problem. That problem can be cleared up when USGS takes the stand.

The Applicant is not harmed by this testimony. Mr. Hamilton has qualified his answer. The Applicant is at no disadvantage at this point.

eb12

What needs to be clarified is the meaning of the map. And thatis best clarified by having USGS take the stand and inform us.

MR. NORTON: Mrs. Bowers, that's exactly what we're saying. I'm not moving to strike any testimony whatsoever, I'm simply saying that to pursue Mr. Hamilton's understanding of "No data" when he says he doesn't know, without any foundation, there is nothing to argue about.

MR. FLEISCHAKER: I'm finished.

MRS. BOWERS: Sustained.

And you're finished?

MR. FLEISCHAKER: I've got everything I need.

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Just for purposes of the record, when our map gets here we'll mark it as an exhibit and mark the places where there is no data, one through four; and we will provide sufficient copies for the record.

MRS. BOWERS: When you talk about doing that, is it your intention to do it today and to pursue the same line of questioning with Mr. Hamilton?

MR. FLEISCHAKER: No. I do not want to pursue this with Mr. Hamilton, but I think it would be useful to have this document in the record.

Can it be marked Intervenors' Exhibit number 18?

MRS. BOWERS: Well, Mr. Fleischaker, let me ask the Staff a question.

Does the Staff intend to sponsor this map through USGS witnesses and bring it into the record?

MR. KETCHEN: One moment, please, Mrs. Bowers.

(Pause.)

No, ma'am, not at the present time.

MRS. BOWERS: Having it come in without a foundation and an explanation would create a problem in the record.

MR. FLEISCHAKER: Well, we've been talking about this map and we've marked it and we've had some discussion on it. I intend to pursue this matter with USGS when they take the stand.

And it seems to me that the record would be

mpb2

totally incomplete unless we have it marked and entered. I don't intend to pursue it any further with Mr. Hamilton because he's indicated he can't make sense of it.

MRS. BOWERS: Well, why don't you hold it until that time rather than having it come in today?

MR. FLEISCHAKER: I'll be happy to do that. I thought it would be better to do it now.

MRS. BOWERS: Fine.

BY MR. FLEISCHAKER:

Q Mr. Hamilton, let me go back to Figure 44, please. The San Simeon is traced there south of its onshore solid marking. Could you tell me the data that you utilized to trace the fault in that manner?

A (Witness Hamilton) I think I understand what you mean. You are referring to the dashed line representing the projection of the San Simeon Fault southeastward from its on-land exposure at Point San Simeon?

Q That's correct.

A Yes.

Q And I mean any data, seismic reflection, aeromagnetic, whatever.

A Yes. There were several lines of evidence that we used, some direct and some less direct, in continuing the trace of the fault where we have shown it to be.

First, to describe the relationships that can be

mpb3

seen in the geology at Point San Simeon on the southwest side of an area of no exposure, or an area covered by younger deposits, one sees very distinctive thin-bedded cherty shale strata of the Monterey formation.

This is separated by an area of partially cemented dune sand deposits that overlie the presumed location of the San Simeon fault from very much older rocks of the Franciscan formation, which locally constitute the basement rock east of the San Simeon fault in that area. So we have two very unlike rocks which must have some considerable amount of displacement between them that are separated by this area of younger deposits at Point San Simeon.

The presumption is that there is in fact the same fault that can be inferred from other lines of evidence farther northwest, and that that fault must go somewhere at least for some distance.

c5

So the question is where does it go?

We know that the trace of the San Simeon fault follows a reasonably well defined course in its on-land reach from Point San Simeon to Ragged Point, twelve miles to the northwest. So we have no reason, at least on that length of the fault, to expect a sharp deviation in its course.

We find that the reach of the coastline that lies about south of Cambria follows a rather linear course that corresponds to the orientation and direction of the course

mpb4

that the San Simeon fault describes farther north.

We know also that the area that lies offshore and southeast of San Simeon Point is the area where this fault must project into the area under the water. And contrary to what the map that we've been discussing recently, a USGS map, an F910, says about that area, actually there are several seismic reflection lines that extend into that area. And one of those lines is of rather high quality. It's the line PBP-2 that was obtained for Pacific Gas and Electric by Aquatronics. And there are several lines from the KELEZ survey, and these show that there is an area that can be traced several miles south from Point San Simeon where the same distinctive thin-bedded sedimentary rocks that lie southwest of the San Simeon fault onshore also exist in the offshore area.

Now in the onshore we see that those rocks lie on the southwest side of the fault, and we believe that it is a positive constraint that the fault must lie east of them in the area offshore to the southeast.

So that's another reason that governs maybe the first couple of dashes that go into the offshore area on Figure 44 southeast from San Simeon Point.

These are at least two lines of evidence, or three lines of evidence that guide us in making this dashed line projection of the fault for some distance south of

mpb5

San Simeon Point.

Q The first line is the geological evidence showing considerable displacement at this point onshore here where it leaves that you indicated with a solid line, is that correct?

A Yes.

Q The second is the shape of the coastline which suggests control by faulting?

A It is suggestive of that, and that falls into the line of an indirect line of evidence.

Q Suggestive?

A Yes.

Q Okay.

The third is seismic reflection data which reveals rocks, a distribution of rocks from which you infer faulting, is that correct?

A Yes; given the relationships that we see onshore we infer a continuation of those relationships in the offshore region to the southeast.

Q Shape of the coastline. Why is the shape of that coastline suggestive of fault control?

A It's simply that it's a rather linear termination of the coast at the water's edge that lines up with the trace of the fault mapped farther northwest.

Now there are other instances in which linear

mpb6

coastlines may exist where there is no reason to think particularly that faulting has anything to do with the linear shape of the coastline. In this case we do have a fault mapped, and that is the prime reason for assigning any kind of significance to the form of the coastline southeast of Cambria.

Q When you say "fault mapped", you mean fault mapped onshore?

A Yes.

Q Okay.

The seismic reflection lines. What kind of seismic reflection technique was used by the Aquatronics?

A We had a sparker seismic reflection line run.

Q High resolution?

A No, we didn't have high resolution. The Aquatronics line yields something approaching the kind of resolution you get with a shallow high resolution. But this particular line was the sparker type line.

Q This is a single channel sparker type line?

A Yes.

Q How about the KELEZ, what do we have there?

A The KELEZ lines were sparker, and I don't presently remember whether they also had uni-boom, which is the high resolution technique, running at that point or not. It was run in some of the area north of Estero Point, I know.

mpb7

But I can't state at this time whether it was in the lines that are in that particular area.

Q Mr. Willingham, can you remember from your study of the profiles whether you studied a high resolution profile in the area of interest that we're talking about right now?

A (Witness Willingham) I don't recall either.

Q Okay.

What is the depth of water in the area where you've traced the fault?

A (Witness Hamilton) It's fairly shallow, but I can't recall the number to state to you without looking at a bathometric map of that area.

Q Can you recall generally whether it is 150 feet, greater, or less?

A No, I can't. I would be guessing.

Q Mr. Willingham, can you recall?

A (witness Willingham) No, I don't recall the water depth specifically.

Q What was it about the distribution of -- strike that.

Do you recall whether the profiles revealed evidence of faulting? That is, penetration, or was it a distribution of rocks that you --

A (Witness Hamilton) The profile doesn't yield

mpb8

useful data as close inshore as the San Simeon fault would be. We interpret smaller faults at other points on the profiles lying west of the San Simeon.

But in the critical area where the juncture between the younger bedded type of Monterey formation rocks and the old Franciscan rocks would be was too close to shore to obtain those records.

Q What was it about the distribution of the rocks that was suggestive of faulting?

A The fact that onshore we see the younger Monterey formation rocks in near-contact with the older Franciscan rocks along what we recognize to be a fault contact farther north -- at points farther north along the coast.

And when we go into the offshore and we see the seismic reflection indication of these same kinds of rocks, rocks that give the kind of seismic returns we would expect from the Monterey formation as we see it onshore, those rocks we see onshore to lie southwest of the San Simeon fault, and those rocks can be seen to extend in the southeasterly direction for several miles south of the point where we are able to see them and examine them onshore, and where we see that they appear to be in fault contact with the Franciscan basement rocks in the east.

Q So you've interpreted that this rock exists

mpb9

there from its signature?

A From its signature and seismic reflection records, yes.

Q Have you gone down and dug up some of these rocks to look at them to determine --

A No, we did not.

Q Will many different kinds of rocks give the same signature?

A The kinds of signature that we see and that we interpret to be correlative with the Monterey formation onshore, I think it is safe to say can be given only by rather distinctly thin-bedded rocks where the bedding has not been greatly disrupted by some kind of later deformation.

Q Well, could they -- thin-bedded rocks, but do they have to be Monterey formation?

A The types of returns that we see in that area is not uniquely correlative with Monterey formation, thin-bedded rocks. But it is certainly unlike anything that exists in the Franciscan formation on the east side of the fault.

Q How farther north do we recognize -- you indicated that -- strike that.

You indicated that further north we find along the coastline the Monterey formation against the Franciscan at a point that we know that there's faulting or infer

mpb10 faulting.

How far north?

A Well, the Monterey formation in the area of San Simeon really goes only for perhaps a fraction of a mile. Beyond there, however, there are other rock juxtapositions that indicate the existence of a fault.

Q Maybe I wasn't sufficiently specific.

You were inferring from the juxtaposition of two kinds of rocks onshore, and the fact that there's faulting there, something about faulting in the offshore region, correct?

A Yes, that's right.

Q Okay.

Where is that onshore location?

A At San Simeon Point and for a distance of a mile or perhaps a little less than a mile to the north of San Simeon Point.

Q Okay.

Any other kind of data? Was there any other kind of data used to infer the San Simeon going southward onland as you indicated here on Figure 44?

A As we have originally drawn up these maps, those were the lines of data that led us to that inference, that the San Simeon fault extended along that dashed line. And our data base wouldn't have allowed us to say exactly where

mphil

the dashed line should stop except that it appeared to not extend into Estero Bay farther to the southeast.

Since that time the aeromagnetic data that was run jointly by the U.S. Geological Survey and the California Division of Mines and Geology has become available to us. And we feel that that data can be viewed as supportive of that same interpretation that we had arrived at from our earlier data base.

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Q Turn to Figure 42, please, is this the aeromagnetic data that you're talking about?

A Yes, this is the aeromagnetic data in the region we're speaking of.

Q How is it that you have -- how have you interpreted this map so that it permits you to extend the San Simeon along the trend south as you have?

5.160

A Well let me say, first, that the faults that are indicated on this map are those that are derived from our previous mapping by other techniques: on-land mapping in the on-land area from San Simeon to Ragged Point, and mapping based on the other kinds of systems that we used in the offshore region.

However, it is my understanding that the linear trough that seems to be associated with the San Simeon Fault on-land appears to continue for some distance to the southeast along the same general trend that one can see on the onshore.

Q Do you have a lot of experience in interpreting aeromagnetic data?

A No, I do not, and that's why I said it is my understanding.

And I think, if you want to get into the theory and the tdetails of aeromagnetic interpretation, I would defer to Mr. Willingham to respond.

Q Okay. Not in detail but I just have a few

agb2

questions.

Looking at the aeromagnetic data, Mr. Willingham, on Figure 42, can that data be interpreted to preclude a connection between the Hosgri and the San Gregorio -- San Simeon, I'm sorry.

A (Witness Willingham) It is supportive of there not being a join between them.

Q That wasn't my question.

A It, in itself, does not preclude, no.

Q Okay.

Could you interpret this data to permit a connection without violating some principle of aeromagnetic interpretation?

A Before answering that directly, it should be understood the potential field data, particularly aero-magnetic data, can be very difficult to interpret because there are a number of physical factors that enter into the creation of the field one observes on the map.

And it's possible that the two faults could join and yield the pattern that we see here, but it would be very unlikely in terms of the particular magnetic conditions that seem to exist in the area.

The alternatives would seem to be: one, the interpretation offered in the direct testimony holds, or two, the San Simeon Fault has to move farther onshore, rather than

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turning in any way seaward.

Q Okay.

But I think I got a "yes" to my question which is that you could interpret this aeromagnetic data to permit a connection without violating the principle of interpretation of that data?

A A very qualified "yes," in that the least likely of all possibilities is that.

Q How much experience have you got in interpreting aeromagnetic data?

A Well aeromagnetic data is not one of the things that I am most experienced in. I couldn't give you an hour rating on it.

Q Do you know whose data this is?

A Well this data was collected jointly by the USGS and the State of California.

Q And do you know who was leading the USGS project at the time?

A Who was the USGS contingent?

Q Yes.

A (Witness Hamilton) May I make a response here?

Q Yes, sure.

A I'll give you my understanding of the matter of the collection of the data, which is that the data was collected under contract to a private firm, I believe

Geometrics, Incorporated.

And the procedure would have been that they would have had a contract to go out and fly, according to a certain density of coverage, a certain geographical area and run that through a standard kind of reduction procedure and thereby derive a map of the magnetic field for the area where that contact covered. This data, I believe, is usually said to be authored by McCulloch, who is with USGS and Chapman.

But the data as released by USGS is not interpreted, it is simply the data that was given to them by the collecting contractor.

Q Good. That's all we have for aeromagnetics.

MRS. BOWERS: Mr. Fleischaker, when there was a brief recess earlier, we asked you to stay in the room and proceed as quickly as possible. We probably should take a 15-minute break now.

(Recess.)

MRS. BOWERS: Are you ready to proceed, Mr. Fleischaker?

MR. FLEISCHAKER: Yes, ma'am.

BY MR. FLEISCHAKER:

Q Mr. Hamilton, I believe that one of the lines of evidence that we were talking about with respect to locating the San Simeon offshore, was the evidence of displacement onshore.

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How much displacement are we talking about there?

A (Witness Hamilton) We don't have any direct measurement of what the onshore displacement is. The San Simeon Fault is evidently rather an old one which displaces ophiolite bedrock, which is bedrock or basement rock that's part of the old oceanic crust against franciscan formation bedrock. And the younger formations such as the Monterey formation at San Simeon rest on top of those bedrock sequences west of the San Simeon Fault.

So we know, at least, that the displacement is of the order of hundreds of feet. But that's only in that local area. And the displacement that one might infer could certainly be much more than that through time.

The displacement, on the other hand, that we see in the latest Pleistocene and the Holocene on the main San Simeon Fault itself is not really detectable by any exploration means I'm familiar with.

Q So that's hundreds of feet of older displacement -- displacement of older rocks?

A In the region right around the San Simeon area.

Q Okay, we'll come back to that.

Dr. Jahns, getting back to the reasons you enumerated for designating a 6.5 magnitude earthquake to the Hosgri Fault, you indicated constraints on accumulated offset I think was the phrase you used.

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What is the accumulated offset that you have interpreted for the Hosgri Fault, both vertical and horizontal?

A (Witness Jahns) This is in the range of 10 to 20 kilometers.

Q Is that vertical or horizontal?

A That's a reasonable figure for horizontal.

Q And how about vertical?

A Vertical is more difficult to estimate, but almost certainly it's less.

Q Do you have a range for the vertical offset?

A I beg your pardon?

Q Do you have a range for the vertical offset on that fault?

A I think Mr. Hamilton has made detailed estimate of that, perhaps he can respond.

Q Okay.

Mr. Hamilton, what are you estimates of the vertical offset for this fault?

A (Witness Hamilton) We find that since middle-Miocene time, about perhaps 10 to 15 million years ago, that the vertical offset appears to be at a maximum on the order of two kilometers, and it decreases, of course, toward the end points of the fault. That is, as I say, since 10 to 15 million years ago.

Q Do you agree with Dr. Jahns' estimate of 10 to 20

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kilometers on the horizontal offset?

A We feel that that is a maximum that is allowable by the constraints to further lateral slip. And the maximum we expect would exist in the central reach of the fault and would likewise die out toward its end points.

However, I feel that a lesser figure is the more likely amount of lateral slip, perhaps in the range of 5 to 10 kilometers.

Q Okay.

Dr. Jahns, both in your oral testimony here today and on the 6th of December, you mentioned several kinds of constraints, and I assume you're talking about the basis for the estimate of horizontal offset. Can you tell us what these constraints are?

A (Witness Jahns) Yes, I could, but I think you could get a more direct and detailed response on that particular topic from Mr. Hamilton.

Q Okay.

Mr. Hamilton?

A (Witness Hamilton) Well, we have identified several types of constraints that appear to limit the possible amount of lateral slip that could exist on the Hosgri Fault. And other workers since have identified some others, I believe.

Q What are those? The ones that you have identified?

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A The first one that we developed, of course, simply had to do with the geometrical restraints on the possible amount of slip that you might expect on essentially an isolated fault.

And that was based on our detailed mapping at the north end and the south end of the fault, which indicated to us that there were not connections that would allow large amounts of cumulative slips say on the order of tens of kilometers to be transferred from that fault to other faults, or from other faults to that fault.

That was a principal element of evidence that we started out with.

Later on, we gained access to the data from a well that was drilled on the west side of the fault called the Oceana well, which was drilled by the combine of oil companies operated by the Standard and Humble in the mid-'60s.

And the data from that well seemed to show a correlation that was uniquely applicable to the general region lying approximatley onshore opposite that part of the fault from where the well was drilled, generally speaking the region from Santa Maria down to the Casmalia area.

So, in looking at the amount of displacement that might have occurred of the section that exists in that onshore area as defined by many wells and also by mapping of observable rocks as compared with the section that was determined by

ag-9

drilling the Oceana well, it appeared to me that something on the order of 10 to 20 kilometers was a reasonable maximum that could be assigned to the possible offset.

The actual data from the well doesn't really require any offset, since it lies approximately on trend with the structures that exist on the east side of the fault onshore.

I think I might mention one other line of evidence that we find generally to have been conformable to our own research, and that's the original map prepared by the Shell Oil Company geologists Hoskins and Griffith, published in 1971, which also shows the Hosgri Fault to be an isolated fault. And this, again, is an indication of a limitation, a geometrical limitation to the amount of slip that can have developed along it.

Q Number Three is a map done in 1971 that tends to support your interpretation of the geometry, Item Number One.

A Yes.

If you would like me to go on and cite one other line of evidence that I have reviewed the data for and found to be apparently conformable with my own observations: This is a line of research that has been pursued by another member of the Geological Survey.

Q Is this mentioned in your testimony?

MR. NORTON: Excuse me, Mrs. Bowers.

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It doesn't have anything to do with whether it's mentioned in his testimony or not, this is cross-examination. Mr. Fleischaker is asking the question and he has the answers when he does so. Just because the answer to his question isn't contained in the direct examination doesn't mean that he can't give it.

MR. FLEISCHAKER: Well, my cross-examination, I asked for the information he had developed, and now he's telling me about information that someone else has developed.

I'm going to ask him about it. I just want to know if it's in his testimony.

MRS. BOWERS: Go ahead.

BY MR. FLEISCHAKER:

Q Is it in your testimony?

A (Witness Hamilton) No, it is not specifically described. In the interest of brevity, we certainly didn't try to make our testimony encompass every element of evidence that we had relied on to reach our conclusions.

Q Okay.

What is it?

A This is an examination of the stratigraphy of an upper-Miocene rock unit called the Sisquoc formation down in the Santa Maria area and called the Pismo formation from about Arroyo Grande north. These are apparently correlative sedimentary rocks.

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And this line of evidence showed that one can map the westerly edge of a part of that formation that contains a prominent basal sandstone unit that overlies the middle-Miocene Monterey section.

And as one traces that, one finds that it lies about 25 or so kilometers east of Point Sal in the region -- in the latitude of Point Sal, and then it can be traced along a somewhat irregular line up the coast. And it's trend aims generally toward the San Simeon region.

Again, the distribution of that unit can be considered to be permissive of some lateral slip. But it seems to not indicate lateral slip. And it would seem to preclude large lateral slip.

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This, incidentally, is described in a publication that was an abstract in the Geological Society of America Corderilla Section meeting in the last year.

Q Who is the author?

A The author's name is Seiders.

Q Are you aware of any responses in the literature to that observation?

A No, I'm not.

Q Was that published in a journal or was it given at the meeting and abstracted in the materials handed out in the meeting?

A The abstract is published in the volume where abstracts are published for that meeting. I'm not aware that it exists in any more extensive published form.

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Q Okay. Let's go to the Oceana well evidence.

These, as I understand, are samples, cores that are brought up from this well that is offshore. Is that correct?

A Several different types of data were obtained from that well. They include various kinds of geophysical logs. They include a complete record of the cuttings that were circulated in the drilling mud as the holes advanced, and they include isolated drill cores.

Q Did you examine the drill cores?

A No, I have not. To my knowledge, they have not

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been released by Standard of California, or at least not to me.

Q What did you examine?

A I examined the well logs, including the annotations as to where the formation breaks were, and I looked at the electric logs as they seemed to correlate with those identifications of formation breaks.

Finally, I examined the very recent U. S. Geological Survey publication which makes a correlation of that well log with the general stratigraphic section in that region.

Q You call this I think in your testimony, and perhaps here today, an Obispo tuff. Is that correct?

A The word would be "tuff," I believe, t-u-f-f.

Q Is that an assembly of various kinds of rocks?

A Yes.

Q Are there volcanic rocks associated with that assembly?

A Yes, that's part of the assemblage.

Q What are they?

A There's quite a variety of volcanic rocks that are included in that general formation. They include, if my memory serves me correctly, basaltic flow rocks and a variety of different kinds of fragmental rocks of more alkaline or acidic character which includes those things that are generally called "tuffs," and "tuff" implies a fragmental rock that has been consolidated into solid rock where the

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fragments are derived from some kind of volcanic erupted source.

Q Are these volcanic rocks often associated-- Can they be associated with the Franciscan formations?

A I think that there are volcanic rocks in the Franciscan formation all right.

Q Isn't it true that-- Well, are you aware of other scientists who have interpreted this data to be consistent with a Franciscan formation and a Franciscan assembly as opposed to an Obispo assembly?

A In the Oceana well, there has been some ambiguity of the interpretation of the section at the very bottom of the well. I'm not aware of anyone who disagrees with the correlation of the section that is essentially next to the bottom with the onshore Obispo formation.

Q Let me ask you specifically: Isn't it true that when you explained this matter to the ACRS that Dr. Thompson, who was consulting to the ACRS, expressed an opinion that the volcanic rocks in this assembly were suggestive to him of a Franciscan assembly?

A I think I would like to see a transcript of Dr. Thompson's testimony and see what part of the section he was referring to.

MR. FLEISCHAKER: I have that transcript here. Let me get it.

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(Pause.)

I have here a copy of the transcript from the ACRS meeting. It's May 21, 1976. It is before the Subcommittee of the ACRS. I am going to give Dr. Hamilton the entire transcript and direct his attention basically to pages 66 and 67 of the transcript, and any other pages before or after which he may wish to consult.

MR. NORTON: May we have a repeat of the citation of that, the page numbers and the date of the ACRS Subcommittee meeting?

MR. FLEISCHAKER: Sure, the date is May 21, 1976, and the pages are 66 and 67. But I'm going to give Dr. Hamilton the entire transcript.

(Handing document to the witness panel.)

BY MR. FLEISCHAKER:

Q I have some markings on there which are just underlines. But why don't you go ahead and review that.

A (Witness Hamilton) Excuse me. Would you point out again the pages you want me to review?

Q 66 and 67, and I believe Dr. Thompson's conclusion is on the bottom of page 67, or his opinion or his suggestion.

MR. NORTON: Excuse me, Mrs. Bowers. Is the purpose of this now-- Are we going to go through the ACRS transcript and pick out little bits and pieces of consultants'

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opinions? If we are, it's a most unusual way to proceed. I didn't know the ACRS transcript was in evidence in this hearing, and if I thought the question were for the purpose of impeaching the witness, I wouldn't have an objection, but it obviously is not so, and I would ask what is the purpose of pulling out ACRS transcripts? We have thousands of pages of ACRS transcripts that may as well go in the record also. I just don't understand.

MRS. BOWERS: Mr. Fleischaker?

MR. FLEISCHAKER: Well, this is not to go into evidence but it is, rather, to be used to test the opinion of this expert, and documents that are used to test the opinion ofthe expert do not necessarily -- often do not go into evidence.

The question is reliability. That's the chief test. And in this case we have a transcript of an ACRS proceeding and we have a consultant to the ACRS who is an expert. And I am testing Dr. Hamilton's conclusions against those that are expressed in this transcript by another expert.

MR. MORTON: Well, Mrs. Bowers, I have a lot of objections if that's the explanation. There is absolutely no foundation. I don't know whether they're talking about Dr. Thompson or Dr. Page. I guess it's Dr. Thompson.

I have no idea about Dr. Thompson's specific qualifications as to this specific subject matter. I don't

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remember, frankly, off the top of my head whether Dr. Thompson is a geologist, a seismologist, a structural engineer, or what. And it is simply a question-and-answer discussion, as I just quickly read these two pages, between Mr. Hamilton and Dr. Thompson.

That's not a proper way to make your case at all. It's not admissible in any way.

MRS. BOWERS: Mr. Ketchen, does the Staff have a position?

MR. KETCHEN: I think we're wandering into the same problem we had earlier this day with respect to the maps and the "No data" thing.

I think the Staff would have no objection to this question if a proper foundation is laid, for example, if a proper foundation is given either on the facts in this case or by another method of getting the facts before the witness so that he can respond. After all, he is presented as an expert and can give his opinion.

So if the foundation is properly laid I think he can answer the question to say what his opinion of that is, whether he knows an answer or not.

I have no particular objection I think to referring to -- allowing the witness to be referred to a document and asking his opinion of that information.

MR. FLEISCHAKER: I think I can-- Maybe I can't

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lay the foundation with respect to Dr. Thompson, but I can try. I don't know what his credentials are but perhaps this witness does.

It's perfectly reasonable, it seems to me-- For example, when you cross-examine a witness on the basis of a document you ask him, do you know this person, is he considered an expert inthe field, have you seen this opinion?

MRS. BOWERS: I think you can attempt to lay a foundation through this witness.

But going to another part of Mr. Norton's objection, is it your intention to take ACRS transcripts and go, line for line, or just what is this the beginning of?

MR. FLEISCHAKER: No, it isn't. I mean there are a few places where, during the course of this proceeding, I may wish to test a witness by referring him to the opinion, either his opinion as expressed in the ACRS transcript or the opinion of another expert as expressed in those transcripts.

But I don't foresee having reliance on that. That's all.

MR. NORTON: Mrs. Bowers, half of what he is proposing is permissible. The other half is totally impermissible. To ask a witness-- If you want to use an ACRS transcript to impeach his testimony, if he says here today the fault is capable of 10 to 20 kilometers offset and yet he testified in 1976 that it was capable of 1,000 to 2,000

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kilometers of offset, then sure, that's usable for impeachment. You say isn't it a fact that you stated so on and so forth?

But to bring in what other people who are not parties to this proceeding, are not witnesses in this proceeding, as to what they said is not permissible whatsoever without laying foundation. And the only way he can lay that foundation is to have that person here so we can cross-examine him.

I don't know what Dr. Thompson knows and what's in Dr. Thompson's head, and I don't have the ability to cross-examine him here. And the ACRS, as you well know, is not a format for finding out what a consultant is thinking or what work he has done or what he knows.

And even if he is a geologist, for example, I don't know what he knows about the Oceana well or the Franciscan formation. Maybe the only thing the man ever knew about it was what somebody told him out in the hall two minutes before the session started, or something. That's why this isn't permissible, because we don't have the opportunity to cross-examine him.

He's not using this to test Mr. Hamilton at all. He isn't saying or intimating in any way that Mr. Hamilton is somehow being contradictory. What he's trying to do is to get Dr. Thompson's opinion in to evidence, and we object

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to that very much because we don't have the opportunity to cross-examine.

Dr. Thompson's opinion may be very good and very well founded, and again it may not, and I don't have the ability to find that out. That's what I'm objecting to, is to get Dr. Thompson's opinion, isolated little opinion on this subject matter into evidence. It's totally contrary; it should not be in the record.

MR. FLEISCHAKER: Dr. Thompson's opinion doesn't go into evidence in a strict way. If we're looking at this in a strict legal way, Dr. Thompson's opinion serves as an expert opinion by which you test this gentleman's opinion. And it is often the case in these proceedings that you use documents that are opinions that are reliable to test the position of the witness.

That is often the case in proceedings where you have -- administrative proceedings where you have expert witnesses on the stand.

MRS. BOWERS: Mr. Norton, how does this differ from something I referred to earlier in the environmental-issue hearing where there were scientific articles?

MR. NORTON: This is not a scientific article. This is a series of a couple of questions and statements between Dr. Thompson and Mr. Hamilton in an ACRS meeting. There is no opportunity for us to examine-- If indeed this

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is an opinion, I believe Dr. Thompson said something like, "Well, I think," or "I believe," or "My impression;" those kinds of things. But there is no opportunity for us to cross-examine the extent of his (a), expertise in the area in which he is expressing an opinion and (b), his specific knowledge of the facts in the specific area in which he is expressing an opinion.

So what Mr. Fleischaker ends up accomplishing is getting the testimony of an -- quote -- "expert" -- end quote -- in, without any ability to cross-examine.

Incidentally, if someone were to put in an article that expressed an opinion, I'd have the same objection.

Now if you can lay a foundation with someone that they've read the article, they've relied on it, and so on and so forth, that's a different matter, but to simply come up with an article and mark it in evidence and say, "Do you agree with his opinion" doesn't get that article into evidence at all without a further foundation.

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MRS. BOWERS: Well, but in the environmental issues hearing there were many scientific articles that did not come into evidence. It's just the witness would be asked Are you familiar with Dr. Expert and have you read his article, and the answer, yes, yes, yes; and then, Do you agree with what he says at page so-and-so and line so-and-so.

I'm still having a problem distinguishing that from this.

MR. NORTON: All right.

If I recall correctly, there were a number of articles that were attempted to be gotten in: in the environmental hearings that did not get in because we objected on the basis -- and if I recall specifically it was Scientific American, Mr. Geokaris had articles from Scientific American and I specifically objected because there was no foundation, there was no way of knowing.

Now, a scientific paper that's published is a different thing. This is just a comment. I have no way to find out about it at all. This is simply the comments of someone, or questions, and I don't know how much thought the man gave to it, whether today he would say, Well, yeah, gee, I had a chance to talk to Mr. Hamilton after the meeting and discuss it a little bit and my opinion is now totally different.

I don't know, this is not a scientific paper at

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all. This is far less than an article in Scientific American. These just happen to be transcriptions of a man's comments.

MRS. BOWERS: I remember when Scientific American was mentioned, Dr. Martin said he enjoyed National Geographic too.

MR. NORTON: Yes, and my son enjoys National Lampoon.

But, you know, it goes down and down and down, and I don't want to get there in this record at all.

MRS. BOWERS: Well, we're going to sustain the objection to the specific reference in the ACRS transcript.

But that does not mean, Mr. Fleischaker, that you can't proceed to question the witness in this area.

WITNESS JAHNS: Mr. Fleischaker, may I offer a comment that may help clarify the geological situation here?

MR. FLEISCHAKER: Let me come back to that, please.

Can I get a statement --

MRS. BOWERS: I think we expressed that. We think it's an appropriate subject, but we do not think it is appropriate to try to set up an ACRS transcript as a scientific treatise.

MR. FLEISCHAKER: I understand that.

I was just trying to recall, I think I had seen something by the General Counsel's office on this matter, but

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I will pass that until lunch time to see if I can find that reference.

BY MR. FLEISCHAKER:

Q Dr. Jahns, yes. Could you, please?

A (Witness Jahns) I think the critical thing here is to examine what the geological section is like onshore, so that we could have more clearly in mind what these ambiguities in a well might be.

The Franciscan, of course, is part of the basement units, relatively very old. The Obispo tuff or Obispo formation is a much younger unit that, by and large, underlies the Monterey formation.

Then we have a third unit that really provides the complication. It's a series of intrusive basic igneous rocks, diabases, basaltic rocks in general, and they are younger than the Monterey.

Now, the problem lies in the existence of these rocks and of mildly metamorphosed equivalents but much older equivalents compositionally, but much older in age that are parts of the Franciscan. So that if rocks of this sort were penetrated in a well it might be difficult to distinguish between them.

The critical thing here is that most of the lithology of the Obispo is essentially unique in that part of the country. These are light colored pyroclastic rocks, as

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Mr. Hamilton indicated, with a kind of peculiar composition. They are latites, high alkali rocks, with this very light color.

Now the point is that there are Franciscan-like rocks higher in the section, but there are no Obispo-like rocks in the Franciscan. And that's the critical thing.

That leads me to believe that the original logging of the Oceana well and the identification of certain units that were penetrated, as Obispo is correct because Obispo is Obispo, so to speak, in terms of its appearance.

Q Okay.

Let me ask you something, then, about the extent of that Obispo.

If we turn to a figure in the Applicant's testimony, it's the one that has the location of the Oceana well on it with a light phase around it -- I haven't the exact number around it, Figure 14, I think.

A Yes, Figure 14 shows the Oceana well.

Q And around the well, which is offshore and designated by a black dot, is a gray area that shows the extent of the Obispo formation.

A Yes.

Q How can we be sure that that is the extent of the Obispo formation?

A No way. We can't be. That's simply a

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cartographic convention on geologic maps where the control is essentially a point, or in this case a line represented by the well.

In order to identify what the well penetrates, the pattern is extended out over an area large enough to be visable.

MR. NORTON: Excuse me, Mrs. Bowers.

May I ask for a clarification of the question? I didn't have a chance.

When he said "how can we be sure that defines the extent of the San Luis Obispo", I got the impression from the question that he was referring to the entire map.

I got the impression from the answer that Dr. Jahns was referring to just the shaded area around the San Luis Obispo well. I may be totally incorrect in my impressions, but that was the impression I got from the question and the answer, that there was a miscommunication there, and I would like -- I'm not sure, Mr. Fleischaker may have had a different meaning than I interpreted.

MR. FLEISCHAKER: Let me see if I can clarify.

I meant the gray hatched area around the well when I said "How do we know that that is the extent".

BY MR. FLEISCHAKER:

Q Is that what you meant in your reply? Is that what you were referring to?

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A (Witness Jahns) Yes, the response was addressed strictly to the pattern around the Oceana well.

Q Okay. Then there was a meeting of minds.

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Q Dr. Jahns, just for purposes of the record, I believe this Figure 13 identifies this black dot out in the Pacific Ocean as the Oceana well. And I take it that that's the same location on Figure 14; is that your understanding?

A Yes; that's correct.

Q Okay.

Well, are there any other wells of which you are aware in this area which would help us exercise some control on the extent of this formation?

A None of which I am aware on the westerly side of the Hosgri Fault.

Q So what information permits us to draw this circle around the well as we have here? That is, how do we know the circle shouldn't extend further to the north or to the south or to the west?

A Well we really don't know. And by cartographic convention that kind of doubt is communicated by the absence of a line that outlines that pattern. On-shore one can see lines that define the extent of the pattern. By convention that indicates actual mapping of boundaries of the outcrop of that particular unit, in this case the Obispo.

But where a line of that sort is absent and the pattern simply bleeds out into nothingness, by convention that indicates one doesn't really know where the boundary is exactly.

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The really critical thing here is that the well on the opposite side of the fault penetrates a unit that is not all that widely distributed on the opposite side of the fault. So this, you see, begins to approach at least good legitimate evidence of the kind a geologist looks at for determining fault separation, something akin to one of the holes in the developing Swiss cheese that I talked about earlier.

The Obispo isn't all that widespread, so the single penetration is very, very significant..

Q I was thinking of the Swiss cheese effect, also.

Well, how do we know what the distribution of this formation is out here west of the fault? We don't have wells out there to limit it. You've indicated in your testimony that there was a limited distribution of this formation. I was wondering what data is it you are relying on to reach that conclusion.

A Well we know that it's limited where we can see it on land. We further know that because of the very nature of the rock we would not expect the same blanket-like distribution that we do expect, and find in the case of something like the Monterey formation. This is a much more localized rock in terms of its genetic relationships.

Now, in addition, there's a different kind of information, less direct but, nonetheless, of interest, that's

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pertinent to the ocean bottom relationships on the opposite side of the fault. And perhaps Mr. Hamilton can comment about that.

A (Witness Hamilton) I'm afraid I've gotten a bit lost in just where we were in the argument. But if I could speak a bit more about the Oceana well, which was the subject of some discussion in that ACRS transcript and has been the subject of a lot of interest since, I'd like to point out that in addition to the Obispo formation, which I think I can state with a good deal of confidence is recognized as being the volcanic formation encountered underneath the Monterey formation near, but not at the bottom of the Oceana well, that that is a formation, as Dr. Jahns has said, of restricted areal extent on shore. It came from a particular set of eruptive vents; therefore you would not expect it to have a very widespread distribution in an offshore area in contrast to the onshore.

But, in addition to that -- that's not the single point about the Oceana well that leads to the opinion that it is uniquely correlative to the region just onshore from it, the other factors that enter into that include the thickness of the formations that overlie the Obispo formation as well as the character of the Obispo itself, and, finally, the character of the material that underlies the Obispo, which I believe was the material that Dr. Thompson was mainly interested

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in when we had our interchange a couple of years ago. --our exchange.

That formation has been the subject of some debate, because there is great heterogeneity of rock types that are indicated in the available logs. But the opinion that is expressed in two different publications that exist on the subject, one by members of the Geological Survey and one by the Shell Oil Company geologists, Hoskins and Griffiths, show that that formation in which the Oceana well bottomed was correlative with the formation that exists near Point Sal called the Lospe formation. And this is a rather distinctive unit; I'd say it is distinctive in its heterogeneity in that it consists of a great variety of sizes of rocks, many of them derived from local basement sources and carried apparently in mud flows or debris flows in very local accumulations. And that rock is exposed in the area near Lions Head and at other points, and it exists on the subsurface at points a little bit south of Point Sal. It doesn't exist elsewhere either in the region down at points very much south of the latitude of the Oceana well nor at other points to the north.

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So this formation which, in its location near Point Sal, includes very distinctive tuffaceous rocks that might well be correlative with the tufts that are reported in the very lowermost part of the Oceana well is the formation that is thought by, I think, most people who have looked at the well now to be that unit in which the well bottomed. And the existence of that formation is even more restrictive in the amount of offset that it allows than is the Obispo formation.

So essentially we have a whole series of units that, by their thickness and by their relatively limited distribution in the case of those at the bottom of the well, all point to a section in the well that is uniquely similar to the one near the Santa Maria-Point Sal-Casmalia area.

Q Let me deal with these formations one at a time. Let's go back to the Obispo.

Were you able to define the extent of that Obispo formation through seismic reflection data?

A The seismic data that we have seen -- that that we have seen allows us to say that that unit that corresponds in the well to the Obispo can be traced for a distance of a few miles away from the well.

But once you get below the Monterey formation which overlies the Obispo and which is a very strong reflecting unit that tends to mask out underlying formations

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because of the existence and the widespread distribution of this Monterey it's not really possible, to my understanding, to confidently carry along a seismic unit that underlies the Monterey, and the Obispo would be such a unit.

So once you've gotten very far away from a control point like the well, then the seismic reflection data doesn't really allow you to make a confident correlation.

Q The answer is that the seismic reflection data doesn't permit a confident correlation on the extent of the formation?

A It points very far away from the control point.

Q Mr. Willingham, do you agree with that from your reading of the seismic reflection data?

A (Witness Willingham) Yes, it's essentially correct.

Q So we don't know one way or the other, is that what it is, looking at the data, the data doesn't permit us to preclude or to infer?

A I guess I would defer to Mr. Hamilton's statement on that. After we get substantial distance away from the control point, then our doubts increase. They increase linearly with our distance from the control point.

Q Your doubts are what, that the formation is there?

A The identification of units.

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Q The signature is masked about this imagery from another strata, is that what it is?

A Yes. When we reach the base of the Monterey formation, things become difficult to interpret.

Q Okay.

A (Witness Hamilton) Could I say one further thing about the distribution of the Obispo?

You've asked, and I felt -- once we get rather farther afield, it is possible to say something about its distribution, and that is that it does not exist in the south flank of the Santa Ynez Mountains, I'm not aware of it being reported in the Santa Barbara Channel area where there is further well control.

Q That's way south, right?

A Yes. It's about, you might say, 80 kilometers south.

Q Where is the nearest well south?

A There's an outcrop section in the south flank of the Santa Ynez mountains and there are various wells in the Santa Barbara Channel region. They're a bit closer than 80 kilometers, but I would be guessing at the exact dimension.

Q Let's talk about that second strata. What was the name you gave that second strata?

A I believe you're referring to the Lospe formation.

agb4

Q Now I think it was your testimony that two workers have identified a rock -- some formation that is similar to this Lospe in the Point Sal area, is that correct?

A Well, it's generally recognized as existing in the Point Sal area, and there are two different interpretations that refer to the section penetrating by the Oceana well as indicating that the bottom of that well was in this Lospe formation.

Q Who were the workers?

A The earlier of these publications was in the paper by Hoskins and Griffith, published in 1971.

In that paper, they present a figure entitled, Santa Maria Basin Stratigraphic Column, and that stratigraphic column essentially corresponds to the general log of the Oceana well down into the, at least the lower-Miocene or Eocene section.

Q And who was the second?

A The second reference is in a U.S. Geological Survey publication that just came out last month which is called, General Geology Petroleum Appraisal and Nature of Environmental Hazards, Eastern Pacific Shelf, Latitude 18 degrees to 38 degrees North. The authors of that are D.G. Howell and D.S. McCulloch and J.G. Vetter.

And that has a figure which is a representation of the general column in the offshore Santa Maria Basin.

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And shown adjacent to that column as a figure is a line identified as Oceana well.

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Q Now is it your testimony that the conclusions in these papers is that the formation that -- the Lospe formation that exists in this Oceana well area is found at Point Sal?

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A I don't remember that the papers specifically state that, but that certainly is the case, that the Lospe formation is found at Point Sal, and in that region. It's not found really very far away from Point Sal.

Q What is the data that permits you to constrain the location of that formation?

A First the mapped outcrop area, which is very limited, and consists of essentially three areas of exposure, one on the north flank of Point Sal Ridge, one out near the point, and one near Lions Head, a short distance south of Point Sal; and the other is the series of wells drilled for oil production that defines the subsurface conditions away from Point Sal, northeast and south.

Q How far northeast and south?

A I am now just giving an approximation, but -- well, certainly the well data goes on for many miles northeast and south. The formation has been identified to a distance I think of maybe -- I'm guessing now. My guess is that along the --

MR. NORTON: Excuse me.

I don't believe it's permissible for witnesses

mpb2

to guess, and I would interrupt this line of questioning that we do not have guessing in the hearing.

WITNESS HAMILTON: Well, let me refer to one of my figures in the direct testimony.

That formation has been identified along an axis of a basin extending 30-odd miles to the southeast and about ten miles to the south from Point Sal.

BY MR. FLEISCHAKER:

Q Are you looking at Figure 13?

A (Witness Hamilton) Yes.

Q Okay.

What is it that gives you the control on this formation here, that is in the gray hatched area which I understand is the Lospe formation on Figure 13 in the offshore area south of Point Sal?

A In the offshore area south of Point Sal? Well, you'll notice once again it is an undefined faded contact, so we see that it exists in the outcrop near Point Sal, and it's reported from wells south of Point Sal under the formations that are exposed on the surface.

So the reasonable geological inference is that it extends at least for some distance along the trend that it has been found onshore into the offshore region.

Q Now looking at the southern extent of this formation here, do you have data, geologic data that precludes

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this formation extending south offshore past Point Arguello?

A Well, the geologic data that exists in that area is restricted to the onshore region. We see no reason-- We see that it doesn't exist onshore and we therefore have no reason to project it into the offshore.

Q Now this area down here by Point Conception that is trending east -- excuse me, west, the formation trends west, what geologic data do you have there that gives you control in the westward extent of that formation?

A Again we don't have any data.

But let me point out that this map is identified as as Sespe and Lospe formations. The two are thought to be age-equivalent but the formation that is shown down around Point Conception is the Sespe formation and that is, in its onshore outcrop area where you can see it, is quite unlike the outcrops that exist around Point Sal, and it is also unlike the material that was described in the different cuttings and analyses from the Oceana well.

In some areas those two formations may intergrade but they are widely separated and quite lithilogically different near the coastline.

Q If I understood your previous answer to one of my questions, it was that you have no geologic data that-- Let me ask you a different question.

In this area, this white area between the two

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gray hatched areas, one going from Point Sal to Carisima Point and the other Point Conception, what is the geologic data that permits you to preclude the existence of the Lospe formation on shore?

A Well, geologic mapping which has been done in great detail by various people such as Thomas Dibblee and also well data.

Q And if I understand your answer, you have no data offshore but you are extending your onshore observations offshore. Is that true?

A Yes, we just extended them as far as they could be reasonably inferred to project along those trends that are defined for many miles to the southeast onshore.

Q Do you, Mr. Hamilton, have any data, any geological data, that precludes the Sespe-Lospe formations down here at the bottom from Point Conception from extending west and north or south?

MR. NORTON: Excuse me. I'm going to object. The question assumes facts not in evidence. I didn't hear any testimony about Lospe formation at Point Conception. I thought the testimony was to the contrary, that there was Sespi.

BY MR. FLEISCHAKER:

Q Let me re-ask the question:

Is that entirely Sespi at Point Conception?

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Mr. Fleischaker would like, to simplify that. I mean if we are going to sit here and go through the articles I would rather have them put in evidence and let them speak for themselves.

MR. FLEISCHAKER: I have a better idea. It's 15 minutes to lunch and I can read them over the lunch break and continue with another line of questioning. How's that?

MRS. BOWERS: Are you suggesting we break now?

MR. FLEISCHAKER: No, I can go on, but I'll move on from this line of questioning.

MRS. BOWERS: Okay.

Can you make copies of those two articles available?

MR. NORTON: I would have to check with Mr. Hamilton and Mr. Willingham. I'm not sure what kind of --

WITNESS HAMILTON: I believe they could be reproduced by xerox.

MR. NORTON: Okay.

MR. FLEISCHAKER: Thank you.

MR. NORTON: Perhaps we could give that to someone to have them take them for that purpose now. If they're going to read them over the noon hour they can't very well be being copied at that time.

WITNESS HAMILTON: Let me ask in the interest of paper conservation if you want to read the entire articles,

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both of which cover very wide-spread areas, or would you prefer just that section that deals with the area around the Oceana well and the Santa Maria Basin?

MR. FLEISCHAKER: Just the area around the Santa Maria Basin and the Oceana well.

MR. HORTON: We would also ask if there is a possibility that these would somehow be put in evidence so that when the copies are made, that the cover be copied as well so that it will identify the source of the article, et cetera, because the middle pages might not do so.

MR. FLEISCHAKER: Let me backtrack on that. I had better take a look at the whole article to be sure.

WITNESS HAMILTON: Okay.

BY MR. FLEISCHAKER:

Q Let me go to the first line of reasoning. We're talking now about the cumulative offset of the Hosgri. The first basis for the position that the cumulative offset was no more than 20 kilometers, 10 to 20 kilometers, was the geometric restraints on an isolated fault on the north end and the south end.

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Are you familiar with the writings of Dr. Clarence Hall on the southern end of the Hosgri Fault?

A (Witness Hamilton) I have read some articles by Dr. Hall, but I can't call to mind one that addresses the question of the southern end of the Hosgri Fault. Can you point one out to me?

Q Yes. Just one moment.

(Pause.)

First of all, for the record, who is Dr. Clarence Hall? What's his position, do you know who he is?

A Dr. Clarence Hall is a geologist and he's a professor, I believe, at UCLA.

Q Is he generally recognized to be knowledgeable about geology in Southern California?

MR. NORTON: That's not a proper question for this witness. We're not going to get into a who's qualified, his qualifications are not in question here. The question isn't relevant and his qualifications are not in question here at all.

MR. FLEISCHAKER: Well I'm about to ask Mr. Hamilton about an article that Dr. Hall has written and I wanted to establish the foundation as to who he was and whether Dr. Hamilton recognizes him as --

MR. NORTON: I believe the foundation for that is whether or not he's read the article, not what his opinion

agb2

of what Mr. Hall is, that's not the subject of this hearing.

MRS. BOWERS: I would think both would be -- we've had some slight identification of Dr. Hall as being professor of -- did you say geology?

WITNESS HAMILTON: Professor of geology.

MRS. BOWERS: At UCLA?

WITNESS HAMILTON: I believe that's the institution.

MR. NORTON: But Mrs. Bowers, I don't think it's necessary, I mean there is no one questioning -- there's no reason for that question to be asked at this point in time.

MRS. BOWERS: Are you saying that you concede he's a recognized expert?

MR. NORTON: Not at all. I just don't think that there is any need for one expert witness to comment on the qualifications of an expert witness at this point in time, there's no reason for that, it's not relevant to these proceedings at this moment. Now maybe a half an hour from now it might be, but right now, that's very unusual for one expert to be asked to comment on the qualifications of another expert. It's a very, at best, awkward question to ask of an expert witness.

MRS. BOWERS: Well, the second part here, too, is: Is it an article from a recognized scientific journal that has peer review.

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WITNESS HAMILTON: Am I being asked that? I don't know what the article is yet, you see.

MR. FLEISCHAKER: This is an article that has been published by Dr. Clarence Hall, and I have it as contained in a report that has been issued by the California Division of Mines, Special Report 137 on the San Gregorio-Hosgri Fault Zone, California, 1978, and this is one of several articles that is published in this special report, and that is the reference to which I am referring. And I believe a copy of this was provided to the Applicant.

MR. NORTON: Mrs. Bowers, let me make my objection clear.

I have absolutely no objection to a line of questioning regarding -- I know Mr. Hamilton has read that report. I have no problems with him asking questions about whether he agrees or disagrees and so on and so forth.

But I also happen to know -- I've had several conversations with Mr. Hamilton about Dr. Hall and I really don't want to get into what Mr. Hamilton's opinion of Dr. Hall is. It just isn't relevant to the record.

MRS. BOWERS: Does the Staff have a position on this?

MR. KETCHEN: Yes, Mrs. Bowers.

This is cross-examination and I think Mr. Fleischaker is simply attempting to lay a foundation before he

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asks questions on the article. And it would seem to me it would be helpful if we had an identification of Dr. Hall in some detail as to who he is and, which we have a little bit of, and I think Mr. Fleischaker was trying to flesh that out a little bit.

And I think it would be helpful to get that on the record, so that when Mr. Fleischaker does get to the point, that we'll know what we're talking about. I think these are in the nature of foundation questions and it is cross-examination, so we would have no objection.

MRS. BOWERS: But the question was put on a very personalized basis, I think, to the witness: What is your opinion of Dr. Hall. Now, I think the witness could be asked a more general question.

MR. KETCHEN: I agree.

MR. FLEISCHAKER: If I put it that way, I didn't intend to put it that way.

MRS. BOWERS: Well it may not have been that.

Anyway the objection is overruled but we hope this will be brief.

BY MR. FLEISCHAKER:

Q Is Dr. Hall generally recognized as a geologist who is knowledgeable about geology in Southern California?

A (Witness Hamilton) Well let me ask, first, what you mean by Southern California.

agb5

Q Well let's put in the region that we're discussing right now.

A You mean South Central California?

Q Yes.

A Oh, I see.

Dr. Hall has published a number of articles and a number of maps and given a number of talks about the geology of that region.

Q In fact, you referred to him in your testimony, didn't you, and you've specifically criticized him, haven't you, or his findings?

A I certainly criticize some of the correlations and some of the structural inferences he proposed.

Q And the two of you have, so to speak, agreed to disagree about certain stratigraphic relationships in the San Simeon and the Point Sal area?

A Unless he has changed his mind more recently than we last discussed the matter, yes.

Q Has he informed you that he changed his mind?

A Not that I'm aware of.

Q Have you had an opportunity to review or examine an article entitled, "The Origin and Development of the Lompoc-Santa Maria Pull-apart Basin and its Relation to the San Simeon-Hosgri Strike-slip Fault in Western California?"

A Yes, I've read that article.

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MRS. BOWERS: Mr. Fleischaker, I should have raised the question earlier. If this is going to be continuing for some time, perhaps we should break for lunch now, it's 12:00.

MR. FLEISCHAKER: Okay, that's fine with me.

MRS. BOWERS: So we'll reconvene at 1:00.

(Whereupon, at 12:00 noon, the hearing in the above-entitled matter was recessed, to reconvene at 1:00 p.m., this same day.)

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AFTERNOON SESSION

(1:00 p.m.)

MRS. BOWERS: We would like to begin.

Whereupon,

RICHARD H. JAHNS,

DOUGLAS H. HAMILTON,

and

C. RICHARD WILLINGHAM

resumed the stand as witnesses on behalf of the Applicant, and, having been previously duly sworn, were examined and testified further as follows:

MRS. BOWERS: Mr. Fleischaker, are you ready to continue.

MR. FLEISCHAKER: Yes, ma'am.

CROSS-EXAMINATION (Continued)

BY MR. FLEISCHAKER:

Q Dr. Hamilton, I'm going to move from Dr. Hall because we're unlikely to get much agreement on the issue, and let me move to the San Simeon.

I think you previously testified and gave us some figures on the amount of offset that you have observed onshore on the San Simeon fault, is that correct?

Could you give me back the figure that you gave this morning?

A (Witness Hamilton) I don't remember that I gave

mpb2

a specific figure. I think that I said that we see differing basement rocks and we see younger Tertiary rocks resting on those basement rocks west of the fault, to indicate that there must be at least some hundreds of feet of displacement. But that was not diagnostic as to what the total might be, and this was cumulative over perhaps 15 million years.

Q Is that horizontal or vertical offset that we're talking about?

A I think that the inferred offset that we see indicated by the Miocene Monterey formation against the Franciscan rock at San Simeon Point is at least -- has a vertical component.

Q Do you have any estimate as to the horizontal offset on the San Simeon Fault?

A Well, I have looked at the geomorphic evidence that is suggestive of right-slip displacement during late Quaternary time, and if indeed the deviated stream courses that cross the -- some traces of the San Simeon fault onland do represent actual fault offset instead of simply the fault being guided -- or the streams being guided in their erosion along a weakened zone of the fault, but if they represent fault offset a figure of as much as 500 meters is indicated over a time span that might encompass perhaps 500,000 years.

I might add that the exposures that one can see at San Simeon Bay between Point San Simeon and the main

mpb3

onland area suggests that no offset has occurred over a span of time approximately equal to the Holocene, on the order of 10,000 years.

Q How about the offshore? Is there any evidence offshore to the north?

A Yes. The San Simeon fault, or a fault extending along its trace can be followed in the seismic reflection records for a substantial distance, like about 100 kilometers north from Ragged Point where the San Simeon fault runs to sea to the northwest. And the records in that area are in an area that's in rather deep water and in steep topography, so one there sees a clear indication of a large amount of vertical offset, since once again something approximating early Miocene time, and I think we've used the figure of about three kilometers of indicated vertical offset between the base of the probable middle Miocene and younger section and the basement rock on the east side of the fault.

Q Do you recall ever having used a figure of five kilometers?

A Well, if to that you add the elevation of the Santa Lucia east of the fault, then you come up with a total figure of about five kilometers for lateral offset -- excuse me, for vertical offset indicated. And this is over a time span of perhaps 50 million years.

Q I'd like to direct your attention to Figure 8.

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And I'd like to ask you some questions about this evidence of offset, and ask you first of all if that's the best figure in your testimony for us to be looking at or is there something better which will give us some point of reference in terms of the regional dimension of this fault zone, the San Simeon?

A Well, the San Simeon fault is indicated on this figure, and there is another one that we have spoken of extensively in past testimony, and I think it's Figure 16. And I'd say that they show essentially the same thing.

I believe that Figure 8 would probably be adequate, but of course I can't say that until your question is developed.

DR. MARTIN: San Simeon fault isn't labeled on my copy.

WITNESS HAMILTON: Yes. Could I describe which one it is?

If you look at the annotation Hosgri on the Hosgri fault, and then you look immediately to the east of that, you see a parallel fault that lies along the coastline and has a little section of coastline lying west of it, and a pair of arrows. And that fault, for a distance of at least, say, one-half or three-quarters of an inch north of the place where you see sea or ocean indicated on the right side of the fault is the San Simeon fault.

mpb5

BY MR. FLEISCHAKER:

Q If you turn to Figure 29 and you get a close-up of that San Simeon -- and I'd like to ask you a question about that figure.

A (Witness Hamilton) Yes, and there's also, of course, a larger-scale figure that shows the details of it, particularly its onshore expression, farther in the testimony. It's also shown on Figure 30, where it was mapped by Hoskins and Griffith.

Q Okay.

With respect to the map -- that is, Figure 29 -- what is the evidence of offset that you find in the area encompassed by the map there that describes the San Simeon fault? What kind of offset do you see?

A All right.

If we look now in the area that lies north of its onshore trace, and shown in very small print there's a place identified as Ragged Point. If we look north of there, particularly between there and Cape San Martin, about an inch and a half north of the Ragged Point area on this map scale, in that area we have -- and to the north of there also, we have seismic reflection line crossings of the San Simeon fault. And these show a section that is up to three kilometers thick of the typical bedded sedimentary rock kind of indications that characterize the offshore

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Santa Maria basin, and these terminate against rock that shows returns characteristic of your featureless basement rock, which can be inferred to be the same rock as that exposed immediately onshore in the Santa Lucia Mountains, the Franciscan formation.

Q So that's three kilometers of vertical offset in that region?

A That's right.

Q What sense of motion do we get from examination of the data? Is there any --

A West down; that's the indicated component in the vertical sense. And the indicated component in the lateral sense is right-lateral based on the geomorphic kinds of indications that I alluded to in the onshore area further south.

Q Do you have an opinion as to the amount of horizontal offset that this fault has accumulated in this area?

A Well, as I mentioned, the opinion that I have of its right-slip during the late Quaternary time, say during the last 500,000 years, might be for the order of 500 meters based on the onshore geomorphic evidence. And I believe that -- I have an opinion that the total of right-slip during the last, shall we say 20 million years would not exceed the amount that's indicated on the Hosgri fault at the central reach of the San Simeon fault, and is, I believe, probably

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much less than that near its end point.

Q That would be 20 kilometers?

A 20 kilometers as a maximum. Probably more on the order of half that.

Q What is your theory as to what happens to that 20 kilometers as we move south from the offshore region onto the onshore area?

A I believe that it's absorbed in the folding which one sees become a prominent part of the geology in the ground west of the San Simeon fault as you come in to the latitude going southward approaching the San Simeon region. There you will see -- on Figure 29 -- this indication of the Piedras Blancos antiform, and that refers to a very pronounced upwarp with a number of splay faults indicated within it.

And the lateral slip and the vertical slip that are concentrated along the San Simeon fault at points north of the antiformal structure gradually translate into folding and into local reverse faulting as you go onto that onshore area. It's clear that the large amount of vertical offset that one sees in the midpart of the San Simeon fault cannot exist in the area right around San Simeon because there we have only a rather thin section of these same kinds of rocks that indicate the three kilometers of offset farther north juxtaposed against basement rocks there.

mpb8

I might add that in addition to the evidence providing a viable and recognized kind of mechanism for absorbing and transforming what is concentrated as fault movement at other points into folding and splaying of fault movement in the Piedras Blancos area, it's also I think a recognized mechanism that faults do change the amount of displacement progressively that can be traced along a strike kind of fault.

Q So this 20 or so kilometers of horizontal accumulated motion is folded up on the onland parts here?

A Well, that amount will probably have decreased to a lesser amount by the time it gets to the area where the Piedras Blancos antiform is the structure adjacent to the San Simeon fault in any case.

The amount of lateral and vertical slip that may exist along the fault doesn't have to remain constant and does not remain constant in places where people have managed to find a whole series of offset corroborative points along the strike of faults, so that our maximum allowable amount which is of the order of 10 or 20 kilometers that might exist in the midpoint of that fault will probably decrease to a few kilometers, and that is the amount that is indicated as being absorbed in folding and reverse faulting in the Piedras Blancos area.

Q What is the evidence that permits you to

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constrain the accumulated horizontal offset on the San Simeon to 20 kilometers?

A I'm looking at the amount of -- let's say the geometrical constraint as to the amount of lateral slip that exists on other faults along the coast that are within the trend line of faults that include the Hosgri and the San Simeon and other faults farther north.

Q Have you developed any stratigraphic relationships that permit you to constrain the horizontal movement along that fault to 20 kilometers?

A No, not along the San Simeon fault itself.

Q Let me see if I understand your answer.

To be consistent with what I've observed in the south, I must limit the movement in the north to 20 kilometers.

A Not only in the south, but also in the north.

Q Okay. Let's go to the north.

What kind of movement -- what is the accumulated offset, horizontal offset on the San Gregorio?

A I believe it is about ten kilometers.

Q Total accumulation?

A I would say, again, with placing a wider limit. I have said in a publication that I think that 20 kilometers is an outer limit, that we feel that ten kilometers is an optimum limit for lateral offset on the San Gregorio during about the last 15 million years, let's say.

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Q Is that the fault to the north that you had reference to when you answered my earlier questions?

A Yes.

Q Okay.

What is the geologic evidence that requires you to constrain movement on the San Gregorio, the accumulated horizontal offset to ten to 20 kilometers?

A Well, there are several lines of evidence. They include stratigraphic and also geomorphic evidence.

Would you like me to ennumerate those?

Q Please.

A Okay.

At the -- first, in looking at the stratigraphic section that lies on opposite sides of the San Gregorio fault in the region around the Santa Cruz Mountains and near Pigeon Point in particular we find that there are sections that include both very wide-spread units, including the Monterey formation, and the younger rocks overlying it, which are stratigraphically equivalent to what we call the Sisquoc and the Pismo formations in the area that the Hosgri fault exists in, but which are called the Santa Margarita and Santa Cruz bloodstone formations in the area of the Santa Cruz Mountains.

So one finds these formations on both sides of the San Gregorio fault. However --

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Q Excuse me. I'm sorry.

I'm interrupting you only because I lost the name of the two formations that you're mapping.

A In the Santa Cruz Mountains area? Well, we spoke of the Monterey formation and overlying that there is the Santa Margarita and the Santa Cruz bloodstone.

Q Do you have a map here that you can show, demonstrate where these two locations are?

A I think perhaps if we went to Figure 2, which is the State map of California.

Q Okay.

Now I think you were giving us your first pair of offset formations.

A No, I wasn't giving offset formations. I was describing the formations that exist in that area.

Q Oh. I thought you were going to give me stratigraphic relationships.

A Well, I am. But we have apparently become lost in talking about those two formations. I was first talking about those formations that are wide-spread, that exist for many miles along the coast from essentially south of Point Conception to north of Point Reyes. And I'm identifying those formations.

Q Okay.

And those were the Santa Cruz --

mpb12

A Those include the Monterey formation and in the Santa Cruz area what is called the Santa Margarita and Santa Cruz Bloodstone formations.

Q Okay.

Now were you going to move on to describe a pair of offsets?

A No, I was going to speak of the formation that underlies the Monterey formation on the east side of the San Gregorio fault in the Santa Cruz Mountains.

And that is a, like the Obispo formation or Obispo tuff, it's a distinctive volcanic formation of limited areal extent. It's contrasted to something like the Monterey formation, which is a very wide spread extent. This volcanic formation exists in the lower Miocene section underlying the Monterey section east of the San Gregorio. That's there mapped on land it's called the Mindego volcanics.

This is a distinctive inter-bedded sequence of pillow basalts; that's basalts that were extruded under water and have a rather characteristic rounded kind of aspect to the texture of the rock, and shale and some sandstone units. This same sequence -- or same type of rock is found in wells that are drilled offshore from Pigeon Point which penetrate this general section of rocks equivalent to the Santa Cruz bloodstone, the Santa Margarita, and Monterey; and they then go into the sequence of volcanics that appears to be essentially

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identical to that which exists east and directly across the fault in the Santa Cruz Mountains.

In looking at the further distribution of these rocks, we can look up points north where one might expect them to be offset if there was very large offset on the San Gregorio fault, and we find that these rocks are absent in the area where the next onshore basin exists, which is called the offshore Bodega basin, and there's the offshore extension of the onshore rocks at Point Reyes.

Now there you have also the Monterey formation, just as you do for hundreds of miles along the coast. You have an overlying section of rocks that also are like those that exist for hundreds of miles along the coast. But you have these in the lower Miocene section; you do not have the volcanics that exist in the Santa Cruz Mountains east of the San Gregorio fault. That is the first stratigraphic point, and that is a fairly loose one. It probably provides a movement constraint that might be of the order of 20 kilometers.

Q Let me see if I understand this.

You found one kind of rock in one place, and you don't find it in the other. Is that basically it?

A I found a distinctive kind of rock on opposite sides and across, directly across the San Gregorio fault at the latitude of Pigeon Point approximately, and I did not

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find it in the next basin that lies west of the San Gregorio fault to the north.

Q Is this of rock, I mean, is this one layer or is this several layers?

A This is several hundred feet.

Q How many strata of different kinds of rock are we talking about here?

A Well, there are two predominant types: basaltic volcanic rock and interbedded shale.

Q And which of these did you not find?

A We don't find the volcanic rocks in the offshore Bodega Basin.

Q So was the absence of this one strata in the offshore Bodega Basin which is your --

A It is absence in the offshore Bodega Basin and it is presence in the offshore outer Santa Cruz Basin west of the San Gregorio Fault of this areally restricted rock unit.

Q Just a question: when we refer to stratigraphic relationship as geologists, do we refer to the absence of a single strata or are we talking about comparisons of several strata which seem to be the same kind of rock and generally the same kind of thickness?

A I don't think you can really define that stratigraphic relationships implies a whole spectrum or range of considerations.

Q Okay, let's go to the next one.

agb2

A Okay, that was a first point of comparison.

A second point of constraint, and actually the one that provides the most specific dimension in terms of lateral offset is the pattern of the gravity anomaly that can be mapped in the region of the Monterey Bay-Santa Cruz Mountains area.

And that is a pattern that is quite distinctive. It is governed apparently by the existence of large upfolded areas called structural highs, of which there are two that lie west of the San Gregorio Fault, with intermediate basins that have corresponding gravity lows.

And a pattern can be discerned in a Clete Bouguer gravity anomaly map which extends obliquely from the offshore in toward the onshore region. It is somewhat distorted as it is carried across the San Gregorio Fault, and then it is seen to be well defined on the ground east of the San Gregorio Fault.

Now, this gravity anomaly pattern is essentially a reflection of the underlying geologic structure, and it tells us what the structure is that is the cumulative product of maybe the last 15 million years or so of structural development there.

And that pattern, when an attempt to restore and remove the distortion that exists at the point where the pattern crosses the San Gregorio Fault, it can be seen that

agb3

the ultimate restoration is achieved by slipping the San Gregorio by about 10 kilometers, that is, removing about 10 kilometers of right slip from it.

So that is a second element that is only indirectly dependent on stratigraphy in so far as the density of the rocks and the amount of the rocks are reflected in the pattern of the gravity anomaly.

Q Mr. Hamilton, do you have a picture of that map in your testimony?

A No, we do not.

Q Do you do a good deal of work with gravity data?

A My firm does. The gravity map of which you speak was prepared by Mr. Willingham here. I am describing what it shows. This description was given in the American Geophysical Union talk last Friday.

Q Has this theory on offset on the San Gregorio, has that been published in the literature anywhere?

MR. NORTON: I object, it assumes facts not in evidence, that it's a theory as opposed to something else.

Mr. Fleischaker has labeled several things theories, but I haven't heard those words come from the witnesses, so I object it assumes facts not in evidence.

MRS. BOWERS: Could you restate the question?

BY MR. FLEISCHAKER:

Q Have your conclusions regarding the amount of

agbl

horizontal offset on the San Gregorio appeared in scientific literature anywhere?

A (Witness Hamilton) My conclusions have not appeared prior to the time of publication of the abstract of the talk on this same subject that I was to have given at the American Geophysical Union Conference last Friday. It is published in the abstract.

Q When you take this gravity data and you -- can you describe the kind of rock that underlie each of these gravity signatures that you would slip together if you were to slip the fault 10 kilometers?

A I think that for a technical discussion of the method, that I would like to defer to Mr. Willingham. Would you prefer that? I can tell you generally what the rock is, because we know that from the offshore borings and the onshore mapping.

Q That's what I want to know, what's the rock. Are we talking about the same -- if we bring the gravity together, the gravity signatures together, do we bring together the same rock?

A We would expect we would bring together the same general pattern of bedrock uplifts or highs and the same pattern of deep basins.

And, in fact, the offshore Santa Cruz Basin will then, I believe, line up with the onshore Santa Cruz

agb5

Basin which contains these distinctive stratigraphic volcanic -- these distinctive volcanic rocks in the stratigraphic sequence that I spoke of as my first point.

You should understand that we are not talking, or at least I'm not talking about pure lateral slip on the San Gregorio Fault. There has also been substantial vertical displacement on that fault.

And because of that, you're moving your rocks on the opposite sides of it in two different dimensions and you're subjecting them to erosion over a long period of time, so you're not going to expect to see exact equivalencies with either a vertical or a pure lateral restoration.

Q Do you interpret this gravity data to require the kind of slip that you interpreted from it?

A No, it is just best brought into an apparently undistorted form where it is intersected by the trace of the San Gregorio Fault by removing the 10 kilometers of slip from the San Gregorio.

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Q Mr. Hamilton, because I can't see it, I can't understand what the distortion is. Could you describe what the distortion is that you're referring to?

A We have a slide which shows this map. It's unfortunate that the slide is a somewhat preliminary edition of a now more complete understanding that we have of the gravity map, so it gives a visual impression of what the form

agb 6

of these anomalies that I'm speaking of is. We don't have any paper copy that could be used for reproduction at this point, though.

Q Well I don't know that we need to take the time to do that. What I was looking for, rather, was a description in the record, so that someone with the technical expertise who looked at it --

A Are you familiar with what -- in general, with what a contour map looks like?

Q Yes.

A All right.

If you imagine a series of contour lines or, perhaps, better yet, I can -- I have another slide that I do have a paper copy of which sort of summarizes these lines of data, and I can show that if you would like, because actually, the contours and the stratigraphic basins correspond in a general way to the gravity pattern.

Would you like that slide to be shown?

MR. FLEISCHAKER: Can we get this into evidence?

MR. NORTON: Are you asking me for a ruling?

MR. FLEISCHAKER: No. He's going to pull out something, I'd like to put it in the record.

MRS. BOWERS: Well I'd put it in the same category as the slides we looked at during Dr. Jahns' oral presentation.

agb7

BY MR. FLEISCHAKER:

Q Let me ask you a quick question, Mr. Willingham.

This piece of paper summarizes the -- I'm sorry, Mr. Hamilton, does this piece of paper summarize the evidence that you're bringing -- which formulates the basis for your conclusion that there is 10 to 20 kilometers of horizontal slip on the San Gregorio?

A (Witness Hamilton) Well the slide I have available -- which I also have an 8-1/2 by 11 paper print showing the same map of -- summarizes a couple of those lines of evidence. We have so far only discussed two of them.

Q Okay. I'd like to see that.

MRS. BOWERS: Now, we did give the one figure an Applicant's exhibit number that was not in the bound direct testimony.

MR. NORTON: This I presume would again be an Intervenor exhibit if it is brought out in cross-examination.

MR. FLEISCHAKER: It's fine with me.

(Slide.)

WITNESS HAMILTON: The map now being projected on the screen is an adaptation of the map presented in the paper by Hoskins and Griffith again. And that's their paper that was published in 1971.

On it, for orientation of the people examining this map, I've shown the San Andreas Fault extending diagonally

agb6

across the map as a prominent red line. I've shown the Franciscan formation basement rock that lies east of that fault and east of the Correcitos Fault near the San Francisco peninsula with a dark green color, and that same basement rock also exists near Point Sur, west of the Serra Hill-Sur Fault.

I have shown the San Gregorio Fault branching off from the San Andreas Fault near Bolinas north of San Francisco Bay and extending as a prominent red line in a southeasterly course including across an onland area near Pigeon Point.

More to the point of the subject that we've been discussing, the brown lines, the thin brown lines on the map are contours that are drawn on what is described by Hoskins and Griffith as the base of the upper-Miocene. It's essentially the top of the Monterey formation, and these contour lines define the existence of a series of west-northwest trending basins that are separated by structural highs.

And in the area near Point Reyes west of the San Andreas Fault, we have the outer Santa Cruz Basin that is shown as a large feature with several 25,000 foot contour spacing contours drawn within it. And immediately south and across the combined Farallon high and Pigeon Point high, we have the outer Santa Cruz Basin.

agb9

You can see, I think, that there's a general west-northwesterly trend in the axis of the basin and to the axes of the intervening highs.

Now, when we look at the gravity map, we find that these axes of the lows, the gravity low would correspond to the basin and the gravity high would correspond to the bedrock high between the basins is fdropped down a little bit as they are intercepted by the San Gregorio Fault and then they take off again.. So that the Pigeon Point high, which you see coming inshore just about at Pigeon Point west of the San Gregorio Fault continues then in the area where the granite outcrop is shown a little bit farther south from that point.

And the outer Santa Cruz Basin is displaced down a little bit and then it continues under Monterey Bay and into the Salinas Basin, which is also a downwarped and downdropped body of low density sedimentary rock.

As a matter of interest on this map, I have also shown the general location of this distinctive volcanic formation, the Mindego volcanics onshore and their outcrop area shown by a solid brown pattern with a hatchered pattern to show their projection in the subsurface.

And similarly, the location of that same distinctive volcanic unit or one that certainly matches it in stratigraphic position and description in the offshore

agb10

outer Santa Cruz Basin immediately across the Pigeon Point high and the Santa Cruz -- the San Gregorio Fault.

And in the offshore region, you see that there are two drill holes indicated by black dots that control the location of that formation.

And we see then that in the Point Reyes area both onshore and in the offshore Bodega Basin there are a number of other drill holes which are extended all the way through the tertiary section which show an absence of that formation.

Does that respond to your question about the gravity high?

Q Let me work backwards a little bit.

The brown hatched parts that are these volcanic rock that you found in one basin and didn't find -- failed to find in the next basin up isthe first line of evidence that you spoke about?

A That's right.

So that we see, if we take this unit as it exists east of the San Gregorio Fault and we look to where we might think it would be displaced into the area farther north, we don't find it. That would be in the case where there was a large amount of right lateral slip with the ground west of the San Gregorio moving northward.

On the other hand, when we look directly in the

agb11

ground across the San Gregorio Fault, we do find this unit.

Q Now let me make sure I understood that. That is one strata that you find.

A Yes. That is a strata that contains this distinctive basaltic volcanic flow rock.

Now, let me show that in this same area we find the Monterey formation and we find the overlying formations. We find them out here, we find them up here, we find them for 300 miles south along the coast on both sides of this fault. We do not find this volcanic unit over such a widespread area.

Q What other similarities do we have in the strata that exist underneath those two basins in terms of strata?

A Well, we have a general similarity of the volcanics being overlain by the Monterey formation, and the Monterey formation being overlain by a section of upper-Miocene and Pliocene rocks that, in the onshore area, are described as the Santa Margarita formation and the Santa Cruz mudstone.

And although those rocks don't exist in this limited area of onshore exposure which is where the uplift has occurred and the rocks have been eroded away, we do find them in the outer basin where the rocks have been preserved just as they are in the Santa Cruz Mountains.

Q How about the thickness of the strata, are they comparable?

agb12

A The thickness of the Monterey formation, as I recall, is somewhat different. They differ by less than a factor of two.

Q What does that mean in terms of feet?

A Well, let me put another slide on, if you would like, which shows the comparative sections in those two areas.

I don't remember at this point, I'd be guessing as to how many feet of Monterey there are on either side of the fault.

I know that the section volcanics is somewhat thinner because, of course, you're several miles away and your amount of accumulation within adjacent basins may vary somewhat.

Q Do you have a slide that shows the strata that compares several levels of strata in one area versus the other area?

A Yes.

Q Could we see that, please?

MRS. BOWERS: Mr. Norton, while they're checking for that slide, this is something I meant to mention and this slide reminds me of it.

Figure Two is color coded.

MR. NORTON: I know.

MRS. BOWERS: And the little black squares in Figure Two mean nothing.

agb13

MR. NORTON: They're all little black squares.

MRS. BOWERS: Yes.

MR. NORTON: The only thing I can suggest is this, and we did this in one other hearing and it takes a little bit of time to get the stuff processed in color, but we can certainly do that. I know it can be done because I've seen it done. And we can certainly do that and use the black and whites in the record for now, and as soon as they are done in color, substitute the colors for the black and whites because here we come with another one in beautiful living color.

MRS. BOWERS: If this is an extremely expensive process, maybe just the three exhibit copies rather than for the transcript.

MR. NORTON: I don't know. In terms of anyone who read the record in any sort of an appeal process, I would just as soon they had the colored slides.

And we'll do that. It's not an extremely expensive process, but it's a lot more difficult than just Xeroxing, of course.

And we'll get it done and we'll make substitutions although, you know, we didn't know we were going to be asked to show these slides, we will be happy to do that if no one has any objection to that.

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We ought to identify the other one before we move on to this one so that we have a clear record.

MR. FLEISCHAKER: That one I believe is going to be Joint Intervenors' Exhibit 18, I believe.

(Whereupon, the document referred to was marked as Joint Intervenors' 18 for identification.)

MR. NORTON: Is that being moved into evidence at this time, or just marked?

MR. FLEISCHAKER: Just marked.

MRS. BOWERS: Are you talking about the slide we saw a few minutes ago?

MR. FLEISCHAKER: This slide here that shows the San Gregoria and --

MR. NORTON: We would move it into evidence at this time, Mrs. Bowers. I think sufficient foundation has been laid to have that marked in evidence.

BY MR. FLEISCHAKER:

Q How about a title, Mr. Hamilton?

MRS. BOWERS: This started out to be an Intervenors' Exhibit and then you just said you would move it into evidence.

MR. NORTON: That doesn't change whose exhibit it is. It is still Intervenors' Exhibit 18, but if he doesn't

eb2

want to move it into evidence, we do.

MR. FLEISCHAKER: I'll be happy to move it into evidence.

MRS. BOWERS: And what about the Staff?

MR. KETCHEN: No objection.

MRS. BOWERS: Well, the figure that is on the screen --

WITNESS HAMILTON: I was going to suggest that is taken from two figures principally that are published in Hoskins and Griffith which are identified as Santa Cruz Basin and Outer Santa Cruz Basin and Bodega Basin, Contours on the Base of the Upper Miocene. That was the main element of evidence that they wished to show.

MRS. BOWERS: Am I correct that that is Intervenors' Exhibit Number 18?

MR. FLEISCHAKER: That's correct.

MRS. BOWERS: So it is accepted into evidence.

(Whereupon, Intervenors' 18, having been previously marked for identification, was received in evidence.)

WITNESS HAMILTON: I have returned to the map figure in order to show that there are three columnar sections, columnar stratigraphic sections in the next slide that we'll be looking at, and they include a section that is

eb3

represented here of the onshore Santa Cruz Basin and the Santa Cruz Mountains indicated here east of the San Gregorio Fault, a columnar section identified from the drill holes in the offshore Santa Cruz Basin, and a columnar section in the Bodega Basin.

(Slide.)

Now these three stratigraphic columnar sections here again correspond to the onshore Santa Cruz Basin that lies east of the San Gregorio Fault, the offshore or outer Santa Cruz Basin or offshore Salinas Basin as it is called by some people, and the Bodega Basin lying to the northwest of Point Reyes.

The part of the section that I am particularly speaking of is indicated in the Lower Miocene part of the column where we have Miocene N.L. indicating lower in the onshore Santa Cruz BAsin where the volcanic part of the Mindego volcanics formation is indicated by this dark red color with interbedded rocks that are meant to indicate shale and sandstone principally underlying the Monterey formation.

Now in the offshore or outer Santa Cruz or offshore Salinas Basin once again in the lower part of the Miocene, the section, we see that we have these volcanic rocks again interbedded with shale, again underlying the Miocene Monterey formation.

When we go up to the Bodega Basin there are some

eb4

volcanic rocks but they are now up in the Middle Miocene part of the section interbedded within part of the Monterey unlike the Monterey in the Santa Cruz area, and they are underlain by a Lower Miocene section of interbedded shale and sandstone with no volcanics.

Now in the area above or the part of the section that lies above the Monterey formation in all areas you find a generally shale or mudstone-rich upper Miocene and Pliocene section which, in the case of the onshore Santa Cruz Basin is identified as the Santa Cruz mudstone with a basal sand called the SAnta Marguerita formation, and a similar kind of sequence of rocks is found in the offshore basin across the San Gregorio Fault, and generally similar rocks are also found in the offshore Bodega Basin.

When you get into the uppermost part of the section which accumulated after these basins were apparently fairly well developed and isolated into separate areas of accumulation in the onshore area there was a thick section of sandstone called the Purisima formation that was accumulated and parts of this formation do exist onshore west of the San Gregorio Fault, but it is not identified in the Outer Santa Cruz Basin lying farther offshore.

Now I think that the question that brought this up --

BY MR. FLEISCHAKER:

eb5

Q. Can we stop here for a moment, please?

MR. FLEISCHAKER: I notice that the witnesses have got up and are talking with Counsel. I think that's kind of unusual.

MRS. BOWERS: Usually Counsel goes over and talks to them.

(Laughter.)

MR. FLEISCHAKER: Usually in hearings that I've been in, Counsel and witness don't talk when they're on the stand.

MR. NORTON: I'm sorry, I'm not talking to Mr. Hamilton. Mr. Willingham came and asked me a question which I answered. Would you like to hear what the question and answer were, or shall we proceed?

MR. FLEISCHAKER: No. I just find it unusual, and I couldn't help but comment on it.

WITNESS HAMILTON: Thinking back on it, the question that gave rise to this rather expanded discussion that I've just given you here had to do with the comparative thickness of the Monterey formation, I believe it was, in the onshore and the offshore area.

We see that in the offshore area there is greater thickness of Monterey than there is in the onshore area, but we find that the total thickness of the Lower and Middle Miocene section, comprising both the volcanic Lower Miocene

eb6

and the Monterey Middle Miocene is 5500 feet, and the total of that is about 5500 also in the offshore basin.

We just see that if you went farther seaward you have a thicker accumulation of Monterey formation rocks and a lesser amount of volcanics reaching into that area.

As we go now to the Bodega Basin farther north, we see that there is a much thinner section, only about 3,000 feet total of the lower and middle part of the section.

BY MR. FLEISCHAKER:

Q Mr. Hamilton, I can't quite make out the numbers over here. Could you give me an estimate for the onshore Santa Maria Basin -- the Santa Cruz Basin for the volcanic section?

A (Witness Hamilton) Okay. That's not broken out as a separate item here but it is a proportion of the total of about 5500 feet in the base of the Lower Miocene to just past the top of the Middle Miocene section, which would lead me to think that it was perhaps 2800 or 3000 feet.

Q Now how about the offshore basin there? There's about 1700 feet?

A 1700 feet in that corresponding section there, and zero feet of volcanics in that part of the section in the Bodega Basin.

Q Okay.

Now again I can't quite read the blue section which

eb7

is the Monterey I believe, on the onshore Santa Cruz Basin. That must be about half of that 5500. Is that correct?

A That's correct.

Q And in the offshore basin it is how much?

A There's about 3800 feet contrasting with the 2,000-odd feet that exist in the section representing the onshore section.

Q One last question: What is the distance in kilometers from the onshore Santa Cruz Basin to the offshore Bodega --

MR. NORTON: Excuse me. Was that to Bodega?

MR. FLEISCHAKER: I'm sorry.

WITNESS HAMILTON: Could we refer to the map slide? I believe it is on the order of 100 kilometers.

BY MR. FLEISCHAKER:

Q Yes, to the Bodega Basin.

(Slide.)

A (Witness Hamilton) I think it is about roughly 100 kilometers from that center section which is in this area here, the onshore Santa Cruz Basin, up to the offshore Bodega Basin. You can see the kilometer scale here and so we step up and I think there are probably four or five of these divisions represented between this area in the onshore Basin and the area in the offshore Bodega Basin.

Q That says miles.

eb8

A I'm sorry. That explains why there seemed to be rather fewer of them in there than kilometers. That would be on the order of 60 miles perhaps.

Would you like to scale it off more directly?

Q Well, it's an exhibit. We can scale it off after the close of the hearings today I guess. If you would like to do it for the record?

A It's about 60 miles from about the center of the Santa Cruz BAsin to the area just where the walls are just south of Point Reyes.

Q Now the stratigraphic section that you have there, which well did that come from? Do you have any idea?

A The sections are approximately the same in the two wells in the OUter Santa Cruz Basin, and I believe that the section in the offshore Bodega Basin is approximately a composite of the six walls that exist in the offshore area.

Q Is that a composite that you made?

A My sections are taken directly from those that were made by Hoskins and Griffith. However, I have also looked at the original electric logs and verified to my own satisfaction that those are the proper kinds of interpretations you would expect to make.

Q Now I'm sorry, I would like to go for a moment to the gravity. The features in which color there are represented by the gravity highs that you discussed as the second

eb9

line of evidence?

A Okay. The geologic features shown on this map that correspond to the gravity highs on a complete Bouguer gravity map are the features that are colored in yellow and pink color identified on the map as the Farallon High, Pigeon Point High and the Santa Cruz High, and then an onshore region, the pink area in the southern Santa Cruz Mountains and the yellow area in the southerly part of Monterey Bay once again correspond to gravity highs.

Q What is it that permits you to limit the location of those formations as you have done there with the colors, the extent of the formation?

A In the onshore area, the area of outcrop is shown in the more solid arcuate brown pattern, and that's shown on the state geological map or other maps that have been prepared for that area.

The hatchered pattern indicates the expected additional area that that formation might be thought to be at the bottom of a structural basin that lies here. However, older rocks can be seen outcropping at points away from this basin, so that we know that the formation doesn't exist in those areas.

In the offshore, the formation was identified in the two wells that I have shown. And from what we know about the character of these basins, we would expect that it would

eb10

occupy the centeral axial part of the sedimentary basin. As was the case in the formation around the Oceana well, we don't know exactly where the limits of its existence here would be, either around the margin or going westerly along the axis, but I think that it's a reasonable inference that exists, at least over the area that we've shown, and we know from the numerous exposures of the subsurface in wells and in the outcrop mapping that it doesn't exist up in the area to the north.

Q I note the wells to the north there offshore. Do you have any other geological or geophysical data that permits you to limit the northern extent of that brown hatched area up to those wells?

A I'm sorry, I don't fully understand the question. When you speak of "those wells" do you mean the wells in the Pidgeon Point area?

Q No, I'm talking about the Point Reyes area. Those, as I understand your testimony, those wells give you control over the northern extent of the brown hatched area.

A Yes.

Well, they were rather carefully located I think by Shell Oil Company to define the maximum part of the basin section and none found that formation. But I have no evidence beyond the -- I think it is a total of ten wells throughout this area here. I do think that that gives quite a good

eb11

sampling though, better than we usually have in a situation like that.

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MR. FLEISCHAKER: We need to mark as Joint Intervenor Exhibit Number 19 the slide that shows the sections of the stratigraphic sections from the two offshore basins and the one onshore basin.

MR. NORTON: We have no objection. I guess it's being offered into evidence as well as marked.

BY MR. FLEISCHAKER:

Q Mr. Hamilton, would you like to give that a title?

MRS. BOWERS: Is it being offered, Mr. Fleischaker?

MR. FLEISCHAKER: Yes, ma'am.

WITNESS HAMILTON: I think we could call it Stratigraphic Columns for Bodega Basin, Onshore Santa Cruz Basin and Outer Santa Cruz Basin.

MR. NORTON: Mrs. Bowers, I don't think we had put a lid on what we're going to do about the color slides.

WITNESS HAMILTON: Let me correct myself for a moment. I see we do assign a title, "Stratigraphic Columns Point Reyes and Santa Cruz Coastal and Offshore Regions, California." I'm sorry for the confusion.

MRS. BOWERS: Let's finish this up first.

Did you express a position on the fact that this slide is being offered as Intervenors' Exhibit Number 19?

MR. NORTON: No objection.

agb2

MR. KETCHEN: No objection.

MRS. BOWERS: Well the slide that has been identified by the witness will be accepted as Intervenors' Exhibit Number 19.

(Whereupon, the document previously referred to as Joint Intervenors' Exhibit 19 was marked for identification and received in evidence.)

MRS. BOWERS: Now, back to the color.

MR. NORTON: I would propose the following if all parties can stipulate to it and that is that we have prepared 8-1/2 by 11, I think it is the size of the transcript, color presentations of these. Also, Figure Two of the direct testimony of Dr. Jahns and Mr. Hamilton and the last two exhibits of Intervenors, 18 and 19. And then we will send the Board members a copy. We will send three copies to the Court Reporter for the official record and a copy to each party, if that is agreed to by everyone.

MRS. BOWERS: You were really treating them like exhibits?

MR. NORTON: Really to substitute it, that's all, it's kind of like substituting an original for a copy, it's the same process.

MRS. BOWERS: But copies of the transcript, of course, go to half the world.

agb3

MR. NORTON: Absolutely, but I wanted to make sure, though, that the Board each had a copy in color in case you wanted to look at it when you were making your deliberations without having to go to get all the exhibits.

MRS. BOWERS: So there would be in the docket file the same number that you normally would have as exhibits, the three?

MR. NORTON: Yes, and I'm saying we'll do that.

MR. NORTON: Well we would send those, of course, to Mr. Bloom.

MRS. BOWERS: Well, how now can people who simply receive copies of the transcript be alerted to the fact that there will be on file --

MRS. BOWERS: And you're really handling this as exhibits.

MR. NORTON: Absolutely, but I wanted to make sure, though, that the Board each had a copy in color in case you wanted to look at it when you were making your deliberations without having to go to get all the exhibits.

MRS. BOWERS: Well but, with an exhibit, we would have been furnished a copy as well as the parties.

MR. NORTON: Yes, and I'm saying we'll do that.

MRS. BOWERS: Well, how now can people who simply receive copies of the transcript be alerted to the fact that there will be on file --

MR. NORTON: Well because exhibits aren't in the transcript anyway. As far as Figure Two goes --

MRS. BOWERS: Well if Mr. Bloom, in his gracious excellence, could put a special notation on the index sheet of today's transcript, it will alert people that there was available to them the color reproduction of their black and white.

agb4

MR. NORTON: Fine.

If there's no objection, that's the way we'll proceed.

MR. KETCHEN: I think that's acceptable, Mrs. Bowers.

MRS. BOWERS: Fine.

And, Mr. Fleischaker, today's transcript in the index will carry a notation that there will be in the docket file three copies of the color-coded sheets, but there's not going to be an attempt made that everyone who receives a copy of the transcript will get a colored sheet. Is that all right with you?

MR. FLEISCHAKER: That's perfectly acceptable.

MRS. BOWERS: All right, fine.

We'll take a 10-minute recess at this time.

(Recess.)

MRS. BOWERS: Mr. Fleischaker.

MR. FLEISCHAKER: Yes, ma'am.

BY MR. FLEISCHAKER:

Q Now Mr. Hamilton, I believe we got off on this line of questioning by talking about the evidence for accumulated offset of the San Simeon Fault Zone.

And I believe it was your testimony that it was 10 to 20 kilometers, and then you indicated that you came to that conclusion as a result of the geometry of, what must be

agb

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the geometry of both ends and the geologic evidence that limited offset in the Hosgri section and the San Gregorio section is that generally it?

A (Witness Hamilton) That's true when looking at the cumulative of possible lateral offset.

I think I also pointed out that the most direct evidence of offset covers a shorter period, perhaps the last 500,000 years and amounts to about 500 meters. I'm not aware of anything that directly requires that there be any substantial amount of lateral offset much beyond that on the San Simeon Fault.

MR. NORTON: Excuse me, Mrs. Bowers, if I might interrupt for a moment.

I think we are in the middle of an answer to a question that has not yet been fully answered. If I'm not mistaken the question was, can you state some of the constraints. And Mr. Hamilton said, yes, there are several, and I think he has given the first two, the ones that deal with Exhibits 18 and 19.

But I believe he said there were others. And we got bogged down in the details of the first two but he never completed his answer by suggesting what the other constraints were, and I didn't want to lose sight of that and not have the question fully answered as if there were only two.

agb6

MR. FLEISCHAKER: Okay. I recall that being his testimony also.

BY MR. FLEISCHAKER:

Q Let's go back, then, to the San Gregorio and what are the -- what is the other evidence that would constrain movement along that fault zone, the accumulated offset?

A (Witness Hamilton) Yes, there are two other lines of evidence that I've worked with.

One is the nature of the course of the Monterey submarine canyon at the point where it is crossed by the San Gregorio Fault. And going along with that, there is also the buried submarine canyon of some sort that lies parallel to the Monterey submarine canyon and north of it.

These are each -- the Monterey submarine canyon, in particular, is a very major subsea topigraphic feature that extends for a length of perhaps nearly 200 kilometers.

Q Could I interrupt you? I always do better when I look at the picture.

Can you identify for me in your testimony which exhibit would be the most useful to look at so you could describe where this submarine canyon lies?

A Yes, I think on Figure Two, once again, if we look at that part of it that covers Monterey Bay, you will see that that is the location of the Monterey submarine canyon which extends in a west-southwesterly trend from the

agb7

center of the easterly part of Monterey Bay and out on into the deep ocean basin outside of the bay.

Now, I tend -- in fact, there are contour lines, bathymetric contour lines on Figure Two that can be seen to define a major canyon coming out from where it says Monterey Bay going across the word, "Monterey," and extending west-southwesterly to the edge of the map coverage.

I also have -- so long as we are figures not included with the direct testimony -- a bathymetric map which shows the detail of submarine bathymetry in that region.

Q Would that be useful in explaining this?

A I think it is useful in visualizing the bathymetric situation there.

Q Could we have that up?

MR. FLEISCHAKER: I imagine I should explain to the Board, one of the reasons for going into so much detail is we have a line of evidence that is substantially different than this, so that we will probably be exploring these two alternative interpretations of offset in this area.

So why don't we see this.

(Chart.)

BY MR. FLEISCHAKER:

Q Now, what is it about this submarine canyon that permits you to constrain the movement along the San Gregorio?

agb8

A (Witness Hamilton) Okay. This is a map that's taken from an official government map showing the subsea contours in the region in and near Monterey Bay.

The Monterey submarine canyon is indicated by the deeper shade of contours, by the deeper shade of blue tones and also by the density of contour lines to extend from a headward point at the head of Monterey Bay and it follows generally a southwesterly course. It takes a bend to the north and continues -- it still is a major canyon feature -- at a distance of nearly 200 kilometers out to sea from its headward point.

This is a very deep canyon. It has a depth of I think at the point where the San Gregorio Fault crosses it -- which is above the region that I'm pointing to, and I find it hard to find for the record but I can annotate it later -- at that point, there is a relief of more than 1200 meters depth or nearly 4000 feet from the upper slopes of that canyon to the bottom of it.

It is cut through rocks that range in age from Pleistocene to at least as old as the middle-Miocene Monterey formation. And below that, it is cut in parts deep into the granite basement. So it's a structure, a feature that has taken a long, long time to form and it cuts through a section of rock that goes through at least 50 million years of history.

agb9

Now for the reference of the Board, the San Gregorio Fault, which is not annotated directly on here, extends from the point where it goes southward offshore near Ano Nuevo Point to where there are several splays at the south end seem to come onshore between Point Lobos and Point Sur, so that the major course of the San Gregorio Fault crosses the canyon at about the point that I'm indicating with the pointer here, and then it extends on southerly apparently into another major tributary canyon called the Carmel Canyon. And as I say, at this point where the fault crosses the canyon, you have the better part of a mile of topographic relief within the canyon.

Now the main course of the canyon has some meanders or twists and turns in it, but in general it forms a straight line that extends almost at right angles to the course of the fault, and it goes directly across the fault without any indicated major deviation.

If you look in detail at these contours, the kind of deviation that is most readily suggested to you actually would seem to show left slip rather than right slip. But certainly at the point where it goes across, we don't see any major deviation of this canyon.

And we are looking, as I say, at a long period of geologic history to form this canyon and to maintain its course in the sea floor.

Could we see the next slide, please?

(Slide.)

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This is a slide that I had redrawn from a map showing contours on the basement, on the basement rock both east of the San Gregorio Fault and west of it that is presented in an Open File report released by the U. S. Geological Survey prepared by Gary Green.

On this map I have shown the outline of Monterey Bay; I have shown the generalized course of the San Gregorio Fault; I have shown a brown dotted-dashed line, the principal course or action of the Monterey submarine canyon. And I think once again it can be seen that that axis now drawn where the canyon is formed and cutting the bedrock, in some places exposed and in some places buried beneath quite old sedimentary rock, also extends without apparent deviation across the trace of the submarine canyon here.

c11

Similarly there is another varied feature that has no sea floor expression under the northerly part of Monterey Bay and that likewise seems to have a continuation that exists on the west side of the San Gregorio Fault.

So here are two major structures or major geomorphic features also represented partly by filled canyons that go across the trace of the San Gregorio Fault and are not offset.

Now let me return to the first slide again.

(Slide.)

Just to be I guess fair to the different opinions

eb2

that have been expressed, Green himself in a paper that I took the last slide from suggests that actually the series of smaller canyons that exist in the outer part of the shelf north of the San Gregorio are themselves offset downstream ends of Monterey Canyon.

I think the individual would have to review the evidence for themselves to decide which idea is right, but it's my personal opinion that the preponderance of evidence tells us that the major canyon has stayed right about where it is for a long period of time. It has not been offset, and these canyons, the heads of which are far removed from the San Gregorio Fault and the heads of which are 1200 meters higher than the point at which the present canyon intersects the fault intercept are not in fact laterally offset downstream continuations of that canyon.

That approximately summarizes my third point of evidence constraining right slip on the San Gregorio.

Q On these canyons, when were they formed?

A Well, the Monterey Canyon was originally formed at least back as early as Middle Miocene time because there are Middle Miocene rocks that are contained within parts of it that are cut into the underlying bedrock.

Its origin is discussed in a couple of different papers, one by Starke and Howard published in the Geological Society of America Bulletin, and there is another one, the

eb3

authors of which I cannot call to mind right now, but it was published in the American Association of Petroleum Geologists Bulletin some time back. Martin and Emory I believe were the authors of that one.

Q How many years ago was that? What year is that Middle Miocene? What period is that?

A That would be on the order of 10 to 15 or 16 million years ago.

Q Okay.

Now over what period of time would it take to create this structure?

A Well, I don't know exactly what time it would take to create it. That's a measure of the time that it apparently has taken to create it.

Q What is the....I think you indicated that the author of this paper, Mr. Green, has interpreted these features on the left-hand upper part of this slide as offset features from the main canyon.

A Yes, that's correct.

Q What is the distance of the furthest of those features from the main part of the canyon?

A Well, we could certainly scale it off this map if we had the part of the scale that covers it. It's on the order of several ten's of kilometers certainly.

Q That would be useful information for the record,

eb4

I believe. Does this slide have a scale on it at the bottom, do you know, or anywhere?

A No, this slide does not. It's a portion of an officially-published larger map I simply took a color transparancy photograph of.

Q I can't see from here. Does it have longitudinal and latitudinal lines on it?

A It does. However, I think if we return to the first of the two map figures that I was working with before our break, that we could scale that distance on them.

(Slide.)

Okay. The Monterey Canyon crosses at about the point I'm indicating in the south central part of Monterey Bay, and the Pioneer Canyon area I believe is somewhere up in this region here. So in general, one is looking at somewhere around 50 or 60 kilometers. That's to the headward part.

Could we go again to the bathymetric map?

(Slide.)

Q I'm sorry. Just to make sure we were four-square there, was that 40 miles that you paced off there?

A Yes. I measured off 40 miles-- Well, you use the equivalent number of kilometers.

MR. NORTON: Let's get the record straight that we're now talking about the map that shows the offsets of the

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canyon and that is subject to something other than holding up fingers in front of a Viewscreen, which I don't think is a very good way to measure distances.

BY MR. FLEISCHAKER:

Q Let me ask you this, Mr. Hamilton: From the location of the latitudinal lines across there and your knowledge about the distance between those lines, can you give us an approximation of the offset?

A (Witness Hamilton) The number I was speaking of was not offset. The number I was speaking of is the distance between Monterey Canyon and other smaller canyons located by the north.

Q Okay. Right. Okay. That's the number I'm looking for.

A Well, I think I should simply sit down and scale it off if you would like the exact number, if I may have a moment.

Q Sure.

(Pause.)

The number still comes out at about 50 kilometers from the intersection of the San Gregorio Fault with Monterey Canyon to the headward part of Pioneer Canyon, the most northerly of the series of branch canyons that one finds along the Continental Slope north of Monterey Bay.

Q Did Mr. Green in his paper reach any conclusions

eb6

regarding the amount of offset that these features might demonstrate?

A Yes, he suggests that this canyon, Pioneer Canyon, is the offset downstream extension of part of Monterey Canyon that lies east of the San Gregorio Fault in Monterey Bay.

Q And was the figure he gave then for that figure around 50 kilometers, do you recall?

A No, I don't recall. The figure is the geographical distance between the points though.

Q Could I please have the cite to that paper by Green?

A I'll have to give that to you at a later time.

Q Okay.

A That's a USGS Open File Report released in 1977 I believe.

Q Okay. That's the third line of evidence I believe; you were suggesting there was yet another.

A That's true. The exposition of the last line of evidence is best done with a series of several slides of maps and is reinforced somewhat by photographs.

Now these are-- I could provide reduced copies of the maps at this time, and one could make color prints of the slides if that would be acceptable.

MR. HORTON: Mrs. Bowers, we had better-- Again because these are slides and so on, before we proceed to

eb7

different lines of questioning, could we get these marked and into evidence before we start getting more and getting them confused?

MR. FLEISCHAKER: I agree.

MRS. BOWERS: The first thing is the witness needs to identify this one as completely as possible.

MR. FLEISCHAKER: This will be Joint Intervenors' Exhibit Number 20.

BY MR. FLEISCHAKER:

Q Could you give this a title, please, Mr. Hamilton?

A (Witness Hamilton) Well, it's a bathymetric map showing Monterey submarine canyon in the Monterey Bay region. And like the paper by Mr. Green or Dr. Green, I can't cite the exact title of it, but I can find it for you.

Q That will do for the record.

(Whereupon, the document referred to was marked Joint Intervenors' 20 for identification.)

BY MR. FLEISCHAKER:

Q Now there was another slide you featured. Let's mark this as Joint Intervenors' Exhibit 21.

What would you entitle this?

A (Witness Hamilton) This is a map showing basement contours in the Monterey Bay Region.

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(Whereupon, the document referred to was marked Joint Intervenors' 21 for identification.)

BY MR. FLEISCHAKER:

Q That's a nice one.

MR. FLEISCHAKER: I would like to move Joint Intervenors' Exhibits 20 and 21 into evidence.

MR. NORTON: No objection.

MR. KETCHEN: No objection.

MRS. BOWERS: Intervenors' Exhibits 20 and 21 are accepted into evidence.

(Whereupon, Intervenors 20 and 21, marked for identification, were received in evidence.)

BY MR. FLEISCHAKER:

Q Now my recollection is that those were the two slides that you presented in connection with this presentation Is that correct? Is there another one?

A (Witness Hamilton) No, these two are the ones that relate to the matter of the evidence for Monterey's submarine canyon.

Q Let's move on then to the fourth line of evidence.

MR. NORTON: Could we give Mr. Hamilton time to

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get the slides together that he's referring to and get them into the machine?

MR. FLEISCHAKER: Sure.

(Pause.)

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WITNESS HAMILTON: Now I have a series of slides that include maps and photographs and I don't know exactly how you want to proceed identifying those as we go.

BY MR. FLEISCHAKER:

Q Why don't we do that and that will save us time at the end. Let's just call this one Joint Intervenors' Exhibit Number 22, and could you give it a title, please?

A (Witness Hamilton) Well let's call it, "Regional Geology Along the San Gregorio Fault Area."

(Whereupon, the document previously referred to was marked as Joint Intervenors' Exhibit 22 for identification.)

BY MR. FLEISCHAKER:

Q Okay.

A (Witness Hamilton) Okay.

This is a map that I prepared to essentially summarize either the elements of evidence or the location of elements of evidence that provide constraints on the possible lateral slip that has taken place on the San Gregorio Fault.

Shown on the map is the nearby reach of the San Andreas Fault extending diagonally across the map area with a green pattern on the northeast side indicating Franciscan basement rock and either an uncolored or a pink pattern

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indicating Salinian basement rock on the west side of the San Andreas, and another patch of green indicating Franciscan basement rock again on the southwest side of the Serra Hill-Sur Fault near Point Sur.

Also shown on this map is the San Gregorio Fault extending southeastward from its point of intercept with the San Andreas near Bolinas extending across its onshore region near Pigeon Point, extending further across the Monterey Bay region and across Monterey Canyon and, finally, going into an area where it splays into several fault branches in the region between Point Lobos and Point Sur.

These several fault branches into which the main San Gregorio Fault splays are identified as the Church Creek Fault, the Palo Colorado and the general Sur Fault Zone, but most notably, the Serra Hill Fault.

The next slide that I will show will be a detail of the area, a more detailed map in this region where the single trace of the San Gregorio Fault splays out into a series of traces south of Monterey Bay.

(Slide.)

The next slide can be identified as one taken from Graham and Dickenson in their 1978 publication, and it is a map showing the faults at the south end of the San Gregorio Fault Zone.

Q If I may interject here, this is Joint Intervenors

agb3

Exhibit Number 23.

(Whereupon, the document previously referred to was marked as Joint Intervenors' Exhibit 23 for identification.)

WITNESS HAMILTON: This map shows essentially the coastline, it shows the brown line and one can identify Point Sur, which is the prominent locator feature in this area, and Point Lobos is farther north up the coast.

It also shows the principal splays of the San Gregorio Fault Zone as it comes onshore east of Point Sur. The San Gregorio itself is branched into two branches which are, in this area, sometimes referred to as the Carmel Canyon [illegible] Fault. And these, in turn, reach the shoreline in the region of Palo Colorado Creek and in the region down around Hurricane Point north of Point Sur.

This diagram was prepared to illustrate one of the factors that indicates why the major -- why, let's say, any major slip that may exist on the San Gregorio Fault farther north cannot very well be taken up on the Palo Colorado Fault or the faults in that area because the map shows that the splay of the San Gregorio which extends onshore as the Palo Colorado Fault and the Church Creek Fault, those faults each terminate to the south against a major cross-fault called the

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Willow Creek Fault.

So if you're trying to get a large amount of lateral slip that may exist at the coastline farther south somewhere into the Santa Lucia Mountains, you find that you're essentially cut off at the Willow Creek Fault for moving that kind of lateral slip farther into the mountains to the southeast.

The diagram also shows that slip, however, could extend from the San Gregorio Fault Zone into the Sur Fault Zone, and particularly into the area where the Serra Hill Fault takes off. Or, if you wanted to pick an intermediate point, you could assign some lateral slip to the Rocky Creek Fault as it's called in this presentation in Graham and Dickenson's paper.

So our three major splays are the Church Creek, the Palo Colorado and the Sur Fault Zone, in general. And the Palo Colorado and the Church Creek seem to come to a dead end here at the Willow Creek cross-fault.

Now the next slide that I will use --

BY MR. FLEISCHAKER:

Q Excuse me, I was just wondering, are the Palo Colorado Fault and the Church Creek Fault as linear as the look on that representation?

A (Witness Hamilton) Yes, those faults -- in fact, the Palo Colorado in particular but part of the Church

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Creek Fault also, in fact, when viewed as an aerial photograph show very striking linear courses and they also show a striking geomorphic aspect suggestive of a right slip, particularly this part of the Palo Colorado Fault. Streams that come in on the northeast side of the fault seem to take off again on the southwest side with about maybe a kilometer of right slip or at least right deviation.

I could show an aerial photograph of this corresponding area, if you would like that impression visually reinforced?

Q No, I have a different question.

How about the zone of faulting on the Palo Colorado, is that a wide zone or a narrow zone or what?

A The Palo Colorado, to my knowledge, is really exposed only, well exposed to where you can actually see the fault itself, at the point where it intersects the coast. There there are two different shear zones where the Palo Colorado runs to the sea cliff here and they are each zones of shearing that are on the order of six or eight feet thick.

Q That's all I have.

MR. KETCHEN: Excuse me one second.

Mr. Hamilton, could you trace the Sierra Hill Fault again?

WITNESS HAMILTON: Yes, the Sierra Hill Fault is the fault that, at the north, extends to the sea coast at

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Hurricane Point to which I am pointing here, and it extends along a somewhat irregular trace across the Point Sur onland area and is mapped to go to a point somewhat south of Pfeiffer Point, where it then again extends offshore.

Now there is a braided-looking system of faults shown on this map. That's because the Sur Fault Zone is an old fault that includes several different breaks, some of them apparently thrust faults with the rather irregular trace that Dr. Jahns describe last week as characteristic of that kind of fault. But the Sur Fault in general sort of follows along the west side of this zone of several faults from Hurrican Point to south of Pfeiffer Point.

Now the next slide I would like to refer to covers the area generally where -- between where the Palo Colorado Fault runs to sea and about Point Sur, and that is a depiction of a very detailed complete Bouguer gravity map that was prepared by a gentleman named Woodson from the Naval post-graduate school and reference has been made to that map before.

The thing that it is particularly useful in showing is the extent to which the main density contrast represented by the juxtaposing of rocks on one side versus the other side of the San Gregorio Fault or the Serra Hill Fault but it does come in right at Hurricane Point.

If we could go to that slide now.

(Slide.)

This would be identified as a complete Bouguer gravity map in the region from Point Lobos to Point Sur taken from Woodson.

MR. LLEISCHAKER: Let's mark this Joint Intervenors' Exhibit Number 24, and what was the title again, please?

WITNESS HAMILTON: It's identified on the figure as Complete Bouguer Anomaly Map, Point Lobos-Point Sur Coastal Region, California, Data from Woodson, 1973.

(Whereupon, the document previously referred to as Joint Intervenors' Exhibit Number 24 was marked for identification.)

WITNESS HAMILTON: Shown in this map is a brown line that indicates the coastline and, again, we have Point Sur near the southerly part of the map, Hurricane Point, the area where the Palo Colorado Canyon and Fault enters the coastline, and Point Lobos just south of Monterey Bay at the north end of the map.

The black lines are contoured values of equal complete Bouguer gravity as determined by Woodson. And finally, the red lines are fault traces that include the trace of the fault coming from the west branch of Carmel Canyon and

extending inshore at Hurricane Point as the Serra Hill Fault as mapped by Woodson. The Palo Colorado Fault on land, the east branch of the Carmel Canyon Fault and two alternative traces that have been proposed on the offshore for the join between the Carmel Canyon and Palo Colorado areas.

One of these, the more westerly, is that mapped by Green in 1973. The more easterly is the one proposed by Woodson from his own interpretation.

Green's data was based on seismic reflection survey and I tend to prefer that as the most likely choice. In any case, they come out at the same point at either end.

Now the significance of this map is, in particular, that you can see a substantial bend in the pattern of gravity values which shows that the main fault boundary that you would pick from a gravity map does, indeed, correspond to the Serra Hill Fault, it doesn't lie somewhere west of it nor somewhere east of it.

Next slide, please.

This next map is a geologic map that covers approximately that same region or a little larger area, and this was based in part on data published by Wagner and by Gilbert, and in part, on mapping done by myself and my associates.

This map again shows the coastline ---

(Slide.)

BY MR. FLEISCHAKER:

AGB 9

Q Excuse me, Mr. Hamilton, let's mark this as Joint Intervenors Exhibit Number 25, and could you give it a name for us?

A (Witness Hamilton) It's essentially a geologic map of the coastal region between Pfeiffer Point and Soboranes Point.

(Whereupon, the document referred to as Joint Intervenors' Exhibit 25 was marked for identification.)

Now this map shows the coastline. It has a number of different colors on it which correspond to different geologic units.

The most important boundary on it is the Serra Hill Fault member within the Sur Fault system which generally separates the crystalline and granatic rocks of the Salanian granite and the Sur metamorphic series rocks on the northeast from a series of Franciscan basement rocks that are locally overlain by rocks of Upper Miocene to Middle Miocene age on the southwest side of this fault system.

Now also shown on this map is the Palo Colorado Fault and the Church Creek Fault. The Palo Colorado Fault locally separates the Salinian crystal rock from Cretaceous-age sedimentary rock, so it is a fairly prominent boundary.

The Church Creek Fault chiefly lies within Salinian basement rock.

But when we get down to the Serra Hill Fault you see we separate now the -- particularly the schist and marble of the Sur series rocks from the Middle and Upper Miocene age sedimentary rocks.

The Rocky Creek lineament or fault lies altogether within Sur series rocks and comes out at a point that is topographically prominent at least called the Pixby Bridge, so this fault does not separate particularly unlike rock types, unlike the Serra Hill or the Palo Colorado Faults.

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Now the element of evidence that's of interest here is that within this series of Upper Miocene rocks generally called the Santa Marguerita Formation on maps that we have but equivalent in time also to parts of the Pisma or the Sisquak Formation further south, within that rock unit there are contained a very distinctive series of breccia which are fragmental sedimentary rocks, and those breccia are derived from -- apparently from the Sur series lithologies that lie immediately across this fault to the northeast.

So the actual appearance would be that these Upper Miocene age rocks in the blue area southwest of the Serra Hill Fault are directly derived almost in place from the crytalline rocks on the other side of the Serra Hill Fault.

Let's go to the next slide, please.

(Slide.)

This now is a view that shows the offshore aspect of the Serra Hill FAult looking northwest from Hurricane Point. The Serra Hill Fault lies under the ocean along the course indicated by my pointer.

And maybe for your convenience the next four or five slides are all photographs, so I can't really describe them except this one might be described as the view northwest out to sea from Hurricane Point.

Q Can we just number these 26-A, B, C, and D, and

eb3

name them as you go through them? This is 26-A.

MR. NORTON: Mrs. Bowers, these are separate exhibits. They are not attached to each other. I don't think it's appropriate to make them A, B, C, and D, and I don't see anything to be gained by doing it other than just successive numbers.

If they were attached together I would agree, but they are not.

MR. FLEISCHAKER: Okay. Your logic prevails.

(Whereupon, the document referred to was marked Joint Intervenors' 26 for identification.)

WITNESS HAMILTON: In the first of the series we have a view looking out across the--

BY MR. FLEISCHAKER:

Q What are we going to call this?

A (Witness Hamilton) I would suggest "View Northwest from 'Hurricane Point across the Trace of the Serra Hill FAult."

Q Okay.

A Shown in this rather scenic view is a large off-shore island and you can clearly see with binoculars that this is composed of marble and schist rock that is characteristic of the basement exposure that lies northeast of the Serra

ehd

Hill Fault immediately onshore to your right.

Across a channel of no exposure one sees a bedded sequence of rocks, and I think the bedding may be visible following approximately the orientation shown by my pointer. And the white looking exposure within these rocks is a sedimentary deposit that is derived of rock types that are identical lithology to these that lie across the Serra Hill Fault.

So this is part of a recognized formation of Upper Miocene age somewhere between maybe five and ten million years old that is composed in part of a talus-like accumulation, rock fragments derived from this type of rock terrain.

Next slide, please.

Q Mr. Hamilton, before you move on on that, what I got out of that is that these rocks are basically the same. They are Upper Miocene rock.

A The rocks on the southwest side of the Serra Hill rock --

Q The same as the one on the other side over there?

A This is a sedimentary deposit made up of fragments of rock incorporated in a sandstone matrix, and the fragments are derived from a basement rock, part of an old crystalline rock mass that lies across the fault. So that the lithology of any given piece of a fragment of rock from this formation is the same as the lithology of a piece that is knocked off

eb5

the parent mass on the opposite side of the fault.

Q Thank you.

(Slide.)

The following slide is a view north-northwest along the bedding of this Upper Miocene sedimentary breccia. You see that it's dipping nearly vertically as shown parallel to my pointer. It's a very rough rock deposit formed of angular fragments mainly of this white crystalline marble and black crystalline schist that is incorporated in a matrix of sandstone and lies within the Upper Miocene Santa Marguerita formation.

Q Let's identify that as Joint Intervenors' Exhibit Number 27.

(Whereupon, the document referred to was marked as Joint Intervenors' 27 for identification.)

Did you want to give that a short title?

A Well, I think we could call it: "View of Santa Marguerita Formation Sedimentary Breccia at Hurricane Point."

Q Okay.

A Next slide, please.

(Slide.)

This is a view downward-- It is I guess a view northwest and down from Hurricane Point to Sea Cliff showing

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the Santa Marguerita formation sandstone. That might do for a title.

Q Joint Intervenors' Exhibit Number 28.

(Whereupon, the document referred to was marked Joint Intervenors' 28 for identification.)

A This illustrates that we do have a sedimentary sandstone deposit on the rock that is the upsection part of the rock formation which includes the breccia that I just illustrated.

Next slide, please.

(Slide.)

The slide shown here is a detailed view of marble and schist fragments contained within the Upper Miocene sedimentary breccia.

Q Let's designate that as Joint Intervenors' 29.

(Whereupon, the document referred to was marked as Joint Intervenors' 29 for identification.)

Q Can you give us a title for that, please?

A I think the words I just spoke would be the title.

MRS. BOWERS: What's the red thing in there?

WITNESS HAMILTON: That there is a geologist's

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hammer shown here, and this is the handle which is about one foot long, shown for scale. And that is resting against these white crystalline marble, very angular fragments here that make up a large part of the composition of this very distinctive rock.

And also included are the darker angular fragments which are crystalline schist that is mixed with the marble in the parent basement rock across the fault.

I have I think one further slide of this.

(Slide.)

This slide might be identified as "View of Sheared Sur Series Schist and Marble Northeast of the Serra Hill Fault."

Q That's Joint Intervenors' Exhibit Number 30.

(Whereupon, the document referred to was marked as Joint Intervenors' 30 for identification.)

A Again, there is a geologist's hammer shown for scale, and this is of about one foot, corresponding to the handle length. This slide shows rock of composition that's identical to the composition of the sedimentary breccia that is separated immediately across the Serra Hill Fault from this crystalline basement rock exposure north of Hurricane Point.

Now I'd like to go back about four or five slides

to the diagram taken from Graham and Dickinson.

(Slide.)

Perhaps this slide will do as well.

The location of the maps and the photographs that I have --

MR. MORTON: We don't know which slide you're looking at on the record.

WITNESS HAMILTON: It's going to be a difficult one to --

MR. FLEISCHAKER: This is Exhibit Number 25, Intervenors' Exhibit Number 25.

MR. MORTON: Thank you.

WITNESS HAMILTON: To recapitulate, the area we just looked at is where the major trace of the westerly trace of the San Gregorio Fault comes onshore and runs ashore at Hurrican Point as the Santa Lucia Fault and then continues on as essentially the only trace of this fault that can extend on to San Gabriel, either than perhaps briefly it being lost within the Santa Lucia Mountains.

And it is within this area might have these distinctive rock types derived from the San Rafael crystalline terrain northeast of the Santa Lucia Fault are found in this Upper Miocene age sedimentary rock immediately southwest of the fault.

Perhaps you could go back a couple more.

(Slide.)

This must be 23, Exhibit 23.

Once again here I pinpoint where our major westerly branch of the San Gregorio Fault runs onshore and it is only from a branch in this region that a trace of the San Gregorio Fault could extend offshore again and thereby go on to join with the San Simeon Fault located offshore farther to the southeast.

The other branches of the San Gregorio are constrained to stop essentially at the Willow Creek Cross-Fault and at this point, at Hurricane Point, we have this rock in the sedimentary section of the southwest side of the fault derived from a distinctive rock on the northeast side of the fault.

This I feel constrains the possible lateral movement of the San Gregorio Fault to no more than a few kilometers of movement in the Point Sur area and perhaps you can add a few kilometers of movement on the Church Creek and the Palo Colorado Fault to add up to probably no more than five kilometers of movement to be expected on the combined traces of the San Gregorio Fault heading south into this coastal region. And that is the fourth of the constraint points that I have identified as restricting the lateral slip on the San Gregorio Fault to not more than 20 and probably more properly about 10 kilometers.

ebl

MRS. BOWERS: Mr. Fleischaker, we have Joint Intervenors' Exhibits 22 through 30. Are you asking that they be admitted into evidence?

MR. FLEISCHAKER: Yes.

MR. NORTON: No objection.

MR. KETCHEN: No objection.

MRS. BOWERS: Joint Intervenors' Exhibits 22 through 30 are now admitted into evidence.

(Whereupon, Intervenors' 22 - 30, previously marked for identification, were received in evidence.)

BY MR. FLEISCHAKER:

Q Mr. Hamilton, I'm sure you have identified it at least two or three times in the record but for my notes, let me see if I can get the name of this rock.

As I understand it, the thrust of this last line of evidence was that you had rocks on the southwest side of the San Gregorio Fault which apparently, by your interpretation, were derived from rocks on the northeast side of the fault.

What do we call those rocks?

A (Witness Hamilton) Well, the rock that lies on the northeast side of the fault is part of the Salinian basement and it's a part identified as the Sur Series

ebll

metamorphic rock which, in this area, are composed chiefly of marble and schist.

Q And on the southwest side?

A On the southwest side immediately adjacent to the fault are rocks of the Upper Miocene Santa Marguerita formation and while dominantly of sandstone, that rock does contain beds interbedded with the sandstone of sedimentary breccia consisting dominantly of fragments of crystalline limestone and schist identical in lithology to the rocks that make up the Sur Series basement rock across the fault to the northeast.

Q And I believe at the end of your statement you indicated that perhaps five kilometers of movement were taken up by the three onshore extensions or possible extensions of the San Gregorio. Is that correct?

A That is my estimate of the probable maximum in that area at the very south end of the San Gregorio for lateral slip.

Q How much of that were you allocating to the most westerly extension, the Serra Hill?

A Well, that's a very qualitative judgment. The geomorphic suggestion of right offset which is most pronounced on the Palo Colorado Fault suggests that during Late Quaternary time we might have had something of the order of a kilometer of right slip on it, and one might imagine a

eb11

similar amount on the next fault to the northeast, the Church Creek Fault.

So the remainder would be-- If you took five kilometers as a nominal figure, the remainder would be two or three kilometers.

I think the geologic evidence does not require or even suggest any lateral slip on the Serra Hill Fault, at least since this Upper Miocene time.

Q Could you explain your theory-- Excuse me -- your interpretation as to how these fragments from the Salinian basement were embedded in the sandstone?

A Yes.

It is my opinion that they represent a kind of a talus or down-slope deposit of rock that has essentially broken off the rising block of the Santa Lucia Mountains, probably in response to upward movement along the Serra Hill Fault, forming an oversteepened slope which, from time to time, will give way and create rock slides or rock falls that would have fallen into an accumulated basin of sandstone or sand during Upper Miocene time.

Q How much upward movement do we have at the fault?

A I don't know that there is any good measure of how much the upper movement is in that area near Point Sur. I think that some of the references mentioned figures of -- minimum figures of on the order of 1,000 or some thousands

eb13

of feet.

Q Were you out in the field in this area?

A Yes. I took those photographs.

4C wbl

Q Did you attempt to make any measurements or make any determinations as to the vertical offset along the fault at that point or its on-land extension?

A No. We examined the fault, and the evidence of movement along that fault clearly shows that the most recent movements, as well probably as those in the geologic past, were dominantly vertical in that area, because the slickensiding and shearing of the various shear planes within the Serra Hill Fault typically are oblique, fairly steeply dipping fabric elements. So we looked at that. But the evidence really isn't there to tell you what the vertical movement might have been, other than that you see a high standard mass of salinian rock that lies in the onshore region and it's adjacent to a basin accumulation type of rock at the seacoast.

Q What is the source of your information that the vertical movement was in the order of thousands of feet?

A Well I think that opinions have been offered by various people who have also discussed the geology of that area. And without seeing the references before me I'm not exactly sure which ones were which.

The two main geologic maps in that region have been prepared by Gilbert as a Ph.D. thesis at Stanford University some years back. And by Trask as a publication for the University of California back in about 1926.

wb2

Q With respect to those three extensions, or possible extensions of the San Grigorio: the Serra Hill, the Palo Colorado and -- what was the third one?

A The Church Creek.

Q With respect to each of those what is your conclusion as to the sense of movement along those faults, the predominant sense of movement?

A I don't have direct knowledge of what the sense of movement on the -- the predominant sense of movement on the Church Creek Fault might be. The Palo Colorado fault I think has fairly clearly moved up on the northeast because it sets crystalline basement rocks against Cretaceous age sedimentary rocks on the southwest. Additionally, in its geomorphic form inland it shows evidence suggestive of some right lateral movement.

The Serra Hill Fault and the exposure at Hurricane Point certainly sets crystalline basement rock against basin type sedimentary rock, and that the crystalline rock and sedimentary rock extend to some depth is suggested by the nature of the gravity anomaly pattern that was mapped by Woodson, shown as one of my slides.

Q What is the predominant sense of movement on the San Gregorio as it's mapped across this Monterey Bay and northern land partsrorth of Monterey Bay?

A Well, if my figure of about 10 Km of right lateral

wb3

movement is correct, then it is predominantly a lateral slip fault. Because I'm not familiar with evidence for more than about perhaps 2 Km of vertical offset along that fault, as for example in the Pigeon Point region.

Q Well is it your conclusion, then, that the San Gregorio is primarily right lateral?

A Predominantly, but not solely a right lateral strike-slip fault.

Q Are you prepared to categorize the Palo Colorado as a predominantly right lateral strike-slip fault?

A No.

Q The sense of movement that you ascribe to the San Gregorio, would that be consistent with calling it a high angle reverse?

A Excuse me; with which fault?

Q With the Palo Colorado.

A I frankly can't remember whether it was a reverse dipping or nearly vertical fault in the one place where one can examine its orientation. I think that it's nearly vertical. So that makes it a high angle fault.

Q But you can't recall whether it has a reverse -- a strong reverse component, or any reverse component?

A I think there's very little, if any, in the exposure that's available for examination.

Q Have you examined the San Gregorio in its onland

wb4

portion near the Santa Cruz or Davenport area, particularly the terraces there?

A I've examined part of the terrace area, and also the places where it is exposed in outcrop in the seacliff near Point Ano Nuevo. I've also examined the offshore records that were obtained along that reach of the fault.

Q What conclusion do you draw from your examination of the terraces with regard to offset?

A My conclusion has been that the terraces south of Point Ano Nuevo are essentially undeformed by faulting.

Q How about north?

A There I haven't really studied the terraces much beyond a few miles north of Point Ano Nuevo. In that reach there certainly are several fault offsets of several feet dimension of the terraces. And there's also was I would characterize as some aspect of fault line morphology along some of the traces of the San Gregorio fault.

Q You personally haven't examined that, though?

A Yes, I have examined that area.

Q What conclusions have you drawn with regard to the recency of movement up there?

A Well the faulting in that area clearly post-dates the time of the formation of the lowest emergent terrace which is offset in several places.

Q What is that date?

wb5

A Well I don't remember now what the most recently assigned data to the age of that terrace is. I can cite work done by others which show that, for example, there is a younger stream fill deposit that is incised into the youngest terrace that has been dated at about 10,000 years. And that is offset by the San Gregorio fault in that area.

Q Who are those workers?

A Well several people from the U.S. Geological Survey have worked in that area. And in the time since Dr. Jahns and I worked there I know that Gerry Weber of the University of California at Santa Cruz has worked in there. Ken Lajoie has worked in that area, from the Geological Survey. And some of his co-workers I know have been active in doing work toward dating the terraces.

Q Now with respect to the-- Have you any calculations with respect to rate of slip on the San Gregorio?

A Well you can take my figure and you can divide it into the age of the rocks that we're dealing with. You can come out with a long term rate of slip on that fault.

Q Do you have a rate of slip in centimeters per year for the last hundred thousand years? Have you done that kind of calculation?

A No, I've not done that for the San Gregorio fault.

Q Are you aware that Weber and Lajoie have done that

wb6

kind of calculation?

A Yes, I've heard that they have.

Q Are you familiar with the figures that they come up with?

A A figure--

MR. NORTON: Excuse me, Mr. Hamilton. The question is: Are you aware of the figure they have come up with? There may be some objections to these questions that we're getting into, so I would like to know the answer to that question.

WITNESS HAMILTON: Well I have it on hearsay as to --

MR. NORTON: I object, then, as to hearsay numbers, Mrs. Bowers. Either he knows the numbers or he doesn't know them. Or if there's a paper that has them. But I don't have any idea of the depth of this hearsay, if it is hearsay. He didn't get it from Weber and Lajoie, I don't think.

MR. FLEISCHAKER: I don't think that's the basis for an objection. If Mr. Norton wants to bring out in his redirect that there is some certainty with regard to these figures I think that's perfectly permissible. But I think it's customary in these hearings for witnesses to refer to oral communications or discussions that they've had, and qualify.

MR. NORTON: That may well be if there is sufficient foundation. But so far all I've heard is the word "hearsay."

MRS. BOWERS: I didn't hear the first couple of words in your response. You were asked if you were aware ofthe figures.

WITNESS HAMILTON: I'm afraid I risk confusion of what I might have said if I tried to recall exactly what I did say.

I have seen a citation that is included in at least one of the papers in this volume that was released by the State recently, to an oral communication to the author of that paper by one of the people who supposedly has made this calculation.

MR. NORTON: On that basis, Mrs. Bowers, thats incredible hearsay. And I would object to the recitation of those figures.

MRS. BOWERS: Do you want to respond further, Mr. Fleischaker, before we rule?

MR. FLEISCHAKER: Well there's a reference in this document here which is a State released document. Apparently Mr. Hamilton is aware of the citation referenced in one of these state documents. I think that's a perfectly reliable document.

MR. NORTON: Mrs. Bowers, the reference is there

wb9

as to hearsay.

MR. FLEISCHAKER: Hearsay isn't objectionable in an administrative proceeding.

MR. NORTON: Well, rank hearsay is.

We have a document which evidently has a citation by an author to hearsay from another person.

Now Mr. Hamilton is being asked if he is somehow familiar with that hearsay information. And it's just too far removed.

I mean, Mr. Fleischaker I hope is going to call witnesses to this hearing sometime, and I would hopw that his witnesses can testify to these things, these hearsay comments he wants to get in from some other source. But to ask our witnesses if we have heard second, ythird, fourth-hand hearsay, and then, What is it? If he's got a number in mind why doesn't he just postulate the question, Will you agree with 'x' number as being possible; yes or no?

I don't know why we have to give his hypothetical number some sort of weight by going this route.

MRS. BOWERS: Mr. Ketchen?

MR. KETCHEN: I think we've gone far afield. I think it's a simple question. The question was, Are you aware of something? The witness answer and drug in the term "hearsay." I think a simple yes or no to that question avoids the problem. I think the witness is perfectly capable of

wb9

answering whether he knows or not this information.

It's not a question of hearsay; it's a question of whether he knows or not. I think this witness is capable of tellingus, in response to the question, whether he knows or not.

I think we're off the point if were talking about hearsay. Maybe the next question will be hearsay. But I don't think this has anything to do with that kind of an objection.

MRS. BOWERS: Well I think the witness identified the source of his knowledge.

WITNESS HAMILTON: In fairness, I guess, to the question I'd have to say that the article to which I was referring actually contains two different citations of evidence of the amount of lateral slip that has occurred on the San Gregorio fault. And one is determined directly by the authors, apparently; the other is cited by them as an oral communication from someone else.

MRS. BOWERS: Well the best evidence rule would have problems with this, I think.

Let's go back, Mr. Fleischaker, to your posing a question similar to what Mr. Norton suggested, and that is, taking those figures, if this witness has an opinion as to the correctness.

MR. FLEISCHAKER: Well that's not the only purpose

wb10

of the question. I mean, the figures spring from my head, hypothetically. There needs to be some foundation for those figures. And I was laying a foundation by questioning him about other workers' estimates of the rate of slip in that area. And then, of course, the following question would have had to be, Do you agree or disagree; and, if you disagree, why?

But I think that I'm able to test this witness' opinion on the basis of measurements and observations and conclusions that have been made by other scientists who have worked in the San Gregorio area and come up with estimates.

Now I have an abstract from the program that--

MR. NORTON: Mrs. Bowers, I have no objection to figures springing from Mr. Fleischaker's head.

MR. FLEISCHAKER: You have.

MR. NORTON: As a question, Do you agree with this rate of slip or not? --there's nothing wrong with that. He can use any numbers he wants.

MR. FLEISCHAKER: That seems to be different from positions you've taken previously. But, in any case, the fact is that it's perfectly permissible, I think, in administrative hearings to test a witness' opinion by reference to conclusions reached by other scientists. And we can go the long way about this: I should maybe have this xeroxed. This is the abstract of a program, precisely the

wb11

same geologic meeting that Mr. Hamilton was going to appear at last year, in which Mr. Weber and Mr. Lajoie presented a paper, calculating and giving their conclusions regarding the rate of slip on the San Gregorio. And I can have this xeroxed and put it before him and ask him if he is aware of this information and is aware of these conclusions, and what his opinion is on them.

It would only take a moment. I will have this xeroxed.

MRS. BOWERS: The witness has in front of him a document, and I think you identified it, Mr. Fleischaker, as a State of California document; is that what it is?

MR. FLEISCHAKER: That's correct.

I'm not sure what he is referring to in here. I didn't refer this to him. I believe that there is a reference to the Weber and Lajoie calculations in some article in here. One of the experts here has relied on this and has annotated the information as an oral communication.

But I have something here a little more tangible; if this is bothersome, and this is an abstract which sets out a presentation that was given by Weber and Lajoie at the geologic meeting in California last year. And it also abstracts and summarizes Weber and Lajoie's conclusions on this matter.

MRS. BOWERS: Well that would be better evidence.

wb12

MR. NORTON: Well, Mrs. Bowers, we would still have an objection to that because it isn't an abstract. But, in any event, I don't understand why he just isn't asked the question, give him the number, and does he agree with it. I don't understand why he has to be shown a piece of paper with a number on it. Why can't he just be asked the question?

I'm lost at why the question can't be asked

MR. FLEISCHAKER: It's simple. I have a right to conduct my cross-examination in my own way.

One of the ways in which someone is permitted to cross-examine another's witness is to test their opinion by comparing it to the opinions of other scientists on the same matters.

These are other scientists, Dr. Weber and Dr. Lajoie, who have worked the terraces in the San Gregorio area. They have mapped the terraces and they have come up with conclusions regarding the amount of offset and the recency of the offset, and have calculated rates of movement in centimeters per year. And I am going to test this witness' conclusions on the basis of these figures.

MR. NORTON: Mrs. Bowers, that again brings us back to the problem we had this morning; and that is, Mr. Fleischaker's characterization of what these two people have done, and our inability to cross-examine them. He has now characterized them as having worked this and worked that

wb13

and done these calculations, and so on and so forth. I don't know, based on a hearsay reference to another document, an oral communication that they have come up with a rate of slip, that all of Mr. Fleischaker's characterizations of what they've done is true. I don't have the opportunity to cross-examine them as Mr. Hamilton's work is being cross-examined.

In other words, he is characterizing it as scientific work. Well that may or may not be: I don't know whether they were there a day, were they there a year, you know, did they dig trenches. What did they do ? I don't know, and I don't have the ability to cross-examine what they did, because Mr. Fleischaker doesn't have them here as witnesses.

What he has is an abstract, which, as I understand it, is something written by somebody else of what he said at the meeting, as the basis for "scientific opinion." And I just think it's totally unfair to the applicant to have to fight that kind of inferential evidence. And what the real basis of the question is is to find out whether or not Mr. Hamilton agrees with that number, and that can be asked directly.

MR. FLEISCHAKER: Taken to its conclusion, or logical extension, that argument would exclude the cross-examination of a witness with a scientific document or a legal

wb14

treatise or -- excuse me; a scientific treatise. And that is a well recognized exception to the hearsay rule.

I think we're a long way from this morning, where we had a statement by a scientist in the ACRS record, to the abstract of a presentation here.

MR. NORTON: Except, Mrs. Bowers, we have no scientific document in front of us. What we're talking about is someone's paper who refers to an oral communication from a third party. That's what we're talking about.

We're not talking about the author's opinion; we're talking about now the opinion of someone who is referred to as an oral communication within that paper. And that's not a scientific document.

MRS. BOWERS: Does the abstract have figures that are identical with the article?

BY MR.FLEISCHAKER:

Q Which article are you referring to, Mr. Hamilton?

A (Witness Hamilton) I'm referring to the one by Griggs and Coppesmith, I believe. Let me identify it more specifically.

Yes, it's the one by, actually, Coppersmith and Griggs, entitled Morphology of Recent Activity in Seismicity in the San Gregorio Fault Zone.

Q On which page do they refer to--

A They refer at the top right -- the top part of

wb15

the right column on page 35.

Q What's the figure that they give?

A They cite--

MR. NORTON: Excuse me; we're not going to get that into evidence that way, Mrs. Bowers. If he has the article in front of him, I would suggest Mr. Fleischaker can read it himself without having Mr. Hamilton read it to him and get it into the record that way.

MR. FLEISCHAKER: Aha. I have it on the bottom of the left column.

MRS. BOWERS: I'm sorry to interrupt this, but there's a special emergency.

We'll take a ten-minute recess at this time.

(Recess)

End 4C

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MRS. BOWERS: We'd like to begin, please.

Mr. Fleischaker, you were asked just before the recess do the figures in the article, are they identical with the figures on the abstract?

MR. NORTON: MRs. Bowers, perhaps we could short-circuit this by having Mr. Hamilton read that portion of the paper from which the figures are in.

Would Mr. Fleischaker have any objection to that? I believe it's just a paragraph, I'm not talking about reading a page, I'm just talking about reading a paragraph. I have a feeling Mr. Fleischaker might object to that.

MR. FLEISCHAKER: I haven't read the paper.

(Pause.)

Pretty good, Bruce.

The opinion I'm looking for is Mr. Weber's and Mr. Lajoie's, not Mr. whoever he is here.

The answer to your question is no, they differ by three-tenths of a centimeter. I mean, they differ by three-tenths of a centimeter.

And the understanding I have is that this abstract is from a 1977 presentation to the Geological Society and this oral communication was taken in 1977 and Mr. Weber had revised his analysis by 0.3 centimeter.

MR. NORTON: Mrs. Bowers, that's nice but that's not evidence. It's Mr. Fleischaker's understanding of what

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maybe he can or cannot prove. But that's another reason for not relying on abstracts, abstracts are not reliable, they're worse than Scientific American, you just can't depend on them.

But I have absolutely no objection to Mr. Hamilton reading the paragraph in the paper that contains the numbers that Mr. Fleischaker is so anxious to ask questions about.

MR. FLEISCHAKER: I'd like to address this because this has come up several times.

And I think that Mr. Norton is mischaracterizing the nature of the exhibit. It is not evidence, and it is not tested by the same criteria that one applies to evidence.

It is scientific opinion that is utilized in cross-examination. And the test for that is some test of reliability. This is an abstract from their delivery at the geologic section meeting. We made an effort to obtain the paper. There was no paper presented, as I've been informed. There was a presentation, an oral presentation made and the only written presentation of the oral presentation is this abstract.

The abstract is about a half a page long and it is rather detailed and contains a number of figures in it. And I think that it measures up to the criteria of reliability that are applicable in an administrative proceeding of this

agb3

nature.

MR. NORTON: I didn't know he was going to move the abstract into evidence.

Who's the author of the abstract, for example, can you tell us that?

MR. FLEISCHAKER: I don't have any idea who the author of the abstract is.

MRS. BOWERS: We've spent a long time on this and our opinion is that if we have two sources of evidence, even though there may imperfections in each one but it may essentially agree, that we can have some feeling of confidence in the figures.

Now, let me ask the witness: Would you consider this discrepancy of three-tenths of a centimeter -- was that it -- in the figures to be substantial?

WITNESS HAMILTON: Well, I believe that given the way that I understand that figure to have been derived, that 0.3 is probably not a substantial spread in the data. I think there probably could be an even wider spread of the data derived in the way that I understand that figure to have been derived.

MRS. BOWERS: We would like to have the figures come into evidence through both sources.

MR. FLEISCHAKER: Okay.

Let me then mark this as an exhibit and distribute

it.

MR. NORTON: Mrs. Bowers, may we have the paragraph read and the article to which the figures are referred into the record. If we're going to have an abstract that goes into the record that was prepared by an unknown author a year ago, I would certainly appreciate having the paragraph where the numbers are referred read into the record.

MR. FLEISCHAKER: The paragraph reflects the views of the author of this article. What we're looking for is the source of the information. As I understand it, the Board would like to have two points for reliability. Reading the paragraph is not at all pertinent to the question before the Board.

If Mr. Norton wants to discredit this view and wants to test Mr. Hamilton's, you know, wants to test Mr. Hamilton's view, he can do that on redirect.

MRS. BOWERS: What we're looking for here now are the figures. If it is necessary to read the paragraph in order to give those figures meaning, there needs to be some way in that article that they can be identified to the two persons who did the work.

Does the sentence in which they appear give that identification?

WITNESS HAMILTON: Well the sentence doesn't really

ebl

set the context of the work that I understand to have been done to give rise to the figures cited in the abstract that I believe Mr. Fleischaker is going to introduce. I actually have not recently read the abstract that I think he's talking about.

MR. FLEISCHAKER: The abstract states I think the basis for the figures. It also identifies the authors and those authors are the same people with whom the oral communication was made that he has referred to in this CDM article.

MRS. BOWERS: Well, let's just have the figures from the article because this gives us, as I say, two imperfect sources but if they are substantially in agreement it's better than the one imperfect source.

WITNESS HAMILTON: Could I suggest that so long as we're talking about some sources of figures there are actually about three different sources of figures that might be considered here, and I would suggest that in my consideration of an evaluation of what the rate of slip on the San Gregorio Fault actually might be thought to be, I would want to look at all of those sources.

MR. FLEISCHAKER: I think we need to get one thing straight at a time. I would like to mark this as a Joint Intervenors' Exhibit, the abstract, just for purposes of identification. I don't intend to move it into evidence.

eb2

MR. NORTON: Our objection is noted.

MRS. BOWERS: The Staff? Mr. Ketchen?

MR. KETCHEN: Mrs. Bowers, let me see if I can summarize before I state a position of the Staff.

I think this started out a long time ago, about half an hour ago, before the break, and Mr. Hamilton was asked the question, are you aware of certain figures, and we then had this go-round for some time now. And I hoped at some point that Mr. Hamilton would then be asked what his opinion is of these figures that were given in the field. And I think he just answered that question. He answered it with a certain amount of qualifiers.

I think he said he couldn't answer it and he would like to see the background material.

Given that premise and given the fact that Mr. Fleischaker is not moving this material into evidence, I'm not sure there is anything to object to at this point. I think the question has been asked and answered, so I just wanted to give you that long answer to your question to state the Staff's position on that.

MRS. BOWERS: Well, we've asked the witness to give the figures from the article.

WITNESS HAMILTON: Well, let me ask another question if I may. Are we talking about the article that is in the California Division of Mines Special Report Number 37

eb3

or the figure that is in the abstract from the GSA meeting, or both of them?

MRS. BOWERS: Both of them is what we have in mind.

WITNESS HAMILTON: Thank you. I'll be happy to respond to that.

First, the figure that is given in the abstract by Weber and Lejoie of 1977 is a sum of the estimates of average rates of offset on the San Gregorio Fault Zone, and they identify several traces and they sum up their estimates of the offset on each of them, and then come up with a range of 0.63 to 1.30 centimeters per year. So that's the 1977 abstract.

The 1978 paper by Coppersmith and Griggs cites an oral communication by Weber, one of the co-authors of the abstract, of long-term geologic rate of offset of fault offset of about 1.6 centimeters per year, and it also cites information that fault creep has not yet been observed or measured along traces of the San Gregorio Fault Zone and field mapping investigations to date have not discovered evidence of offset cultural features.

This is attributed to a personal communication from Weber and Lejoie, 1977.

Then this article also contains information --

BY MR. FLEISCHAKER:

eb4

Q Excuse me, Mr. Hamilton. I don't think I asked you that question.

A (Witness Hamilton) Well, I believe the Board did ask me what the article here said. There are figures for rate of fault offset.

Q My understanding was the Board was interested in the Weber and Lejoie figures.

MRS. BOWERS: Didn't you just give us that?

WITNESS HAMILTON: Well, I asked-- If my memory serves, I asked you the question, was it appropriate for me to give the figure that is cited in the abstract by Weber and Lejoie from 1977 and also the figure that is cited in the paper in Special Report 137.

MRS. BOWERS: Well, but you just gave the figure from the paper. I thought that was the--

WITNESS HAMILTON: I gave you one figure but there are actually two different figures in that article.

MR. NORTON: Mrs. Bowers, I object to this use of these kinds f cpapers. But I do know this: If on cross-examination you risk bringing up a paper, you're stuck with the whole thing, not your selective little piece of it.

MR. FLEISCHAKER: I didn't bring that paper up. Mr. Hamilton brought it up in the first place. I brought up the abstract.

MR. NORTON: Well, I'm afraid Mr. Fleischaker

eb5

brought up the oral representation which is contained in that paper. There is no oral representation in this. The oral representation is in that paper.

If Mr. Fleischaker is going to use it he's going to have to eat the whole thing. He can't just take the frosting off of it.

MR. FLEISCHAKER: Well, I didn't bring that up.

WITNESS HAMILTON: Was I asked the original question of was I aware of a cited figure in the literature for the rate of slip on the San Gregorio Fault? Was that the original question?

MR. FLEISCHAKER: I don't remember what the original question was. I'm not sure that it would do us much good to go back to that point.

WITNESS HAMILTON: Because I came to this as the most recently published article that I had read to respond to the question you had asked me I believe.

MR. FLEISCHAKER: Wait a minute.

Mrs. Bowers, I think that where we are as a legal matter is we're discussing whether I can cross-examine this witness on the basis of the estimates of rate of slip that have been made by Dr. Weber and Dr. Lejoie, and I would like to limit my cross-examination to that point.

MRS. BOWERS: We have two sources.

MR. FLEISCHAKER: For the Weber and Lejoie

estimate?

MRS. BOWERS: For the Weber and LeJoie estimate. The witness read from a second source.

MR. NORTON: Mrs. Bowers, we would ask that that source that he was asked to read from be marked for identification as was this source.

MRS. BOWERS: THey were citing Weber and Lejoie figures.

WITNESS HAMILTON: Not exclusively.

DR. MARTIN: We can't get very far unless we know what we're talking about. Would you like to take a few minutes off to figure out what this is about?

MR. FLEISCHAKER: I think I understand, Dr. Martin, what it's about.

DR. MARTIN: Well, please enlighten me because I am utterly confused. I don't know what's going on.

MR. FLEISCHAKER: Okay. But I would like to cross-examine this witness on this one thing. That one thing is the estimates of rate of slip that have been calculated by two scientists who have done work on the San Gregorio. Those two scientists are --

DR. MARTIN: The scientists mentioned in this abstract?

MR. FLEISCHAKER: That's correct, Drs. Weber and Lejoie. Now they made calculations regarding the rate of

eb7

slip and their calculations are listed here in the abstract which you have before ycu.

In addition, there has been a reference to that calculation in an article written by two other scientists and if I understand the Board's ruling, it was that we would permit this line of cross-examination because we have two sourcas for the estimate rate of slip. The one estimate comes as a citation in a paper by other authors. And the one comes from the citation here in the abstract, which abstracts the work of the two scientists.

What is happening is that Mr. Norton is trying to get into evidence the opinions and the observations of two other scientists, Coppersmith and Griggs. Mr. Norton may wish to do that on the redirect; that's fine. I don't wish to do it now. I want to cross on one thing, the Weber and Lejoie work and their estimated rate of slip -- period.

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MR. NORTON: My brief response is if he's going to ask a question out of that paper then that has to be marked for identification, too, as is this paper, because they are two different numbers. One was an oral communication that is not, obviously, the result of this because it's a different number. Somebody is wrong.

All we're asking is that it be marked for identification, as is this. It may not be in evidence but it's in the record that would go up on appeal even though it isn't necessarily marked in evidence.

MRS. BOWERS: And what exhibit number would that be? Are we talking about having it marked as a Joint Intervenors' exhibit?

MR. NORTON: Well, he's using the document and if he's using the document he should have it marked. You know, just because it's got my name on it or his name on it, you know, it doesn't mean that --

MR. FLEISCHAKER: I think that as a legal matter it's the Board's Exhibit because Mr.Hamilton brought it up and the Board wanted the additional exhibit to test the validity of the abstract.

MR. NORTON: I'd have no objection to making it a Board Exhibit.

MR. BRIGHT: While we're trying to untangle the legal problems here, perhaps one of you gentlemen could tell

eb2

me what kind of Boolean algebra or whatever is going on here. It says the San Gregorio Fault Zone is the sum of the above, and when you add those up they don't come out to that number.

MR. NORTON: Well, Mrs. Bowers, again that's the problem I had with abstracts. The abstracts are very crude. I can show you an abstract of the Fugro report that is so far off on the Fugro report that you can't believe it, and that's what we first saw and we about fainted. Then when we saw the Fugro report we found it didn't say that at all. Abstracts are very, very crude instruments. They're not scientific papers or anything like it. That's my objection to this.

WITNESS HAMILTON: I can't vouch for Mr. Weber's and Mr. Lajoie's arithmetic.

(Laughter.)

MRS. BOWERS: Well, the article that has been used by the witness as his source of the Weber and Lajoie figures will be marked for identification as Board Exhibit Number 3.

(Whereupon, the document referred to was marked as Board Exhibit Number 3 for identification.)

MR. FLEISCHAKER: We have a copy of it but we don't have xerox copies of it right now. We're not going to offer it into evidence. We can mark it as an exhibit

eb3

for purposes of the record and give sufficient xerox copies around.

Now this document-- Let me make sure. This document is an enormous thing. Does the Board want the whole document or the article?

MRS. BOWERS: Just the article. But there should be a cover sheet identifying the location of the article.

MR. FLEISCHAKER: Sure.

BY MR. FLEISCHAKER:

Q Mr. Hamilton, the calculations that you are aware of range from a maximum of -- well, range from .63 to 1.6 centimeters per year. Is that correct, that have been calculated by Weber and Lajoie?

A (Witness Hamilton) That is the number that is printed in this abstract.

Q All right.

Let me ask you this: Are you aware of these calculations? Have you discussed these calculations before?

A Yes, I've discussed them briefly with Mr. Lajoie.

Q When did those discussions take place?

A Probably some time over the last year, but I speak with Mr. Lajoie on various occasions and I can't identify just when.

Q Mr. Lajoie, as I understand it, works at USGS?

A That's correct.

eb4

Q Now I'm trying to reach back. Have you done comparable calculations yourself?

A Yes, I have made a calculation as to what the long-term rate of slip on the San Gregorio Fault is.

Q Now is that long-term the same term that Weber and Lajoie are using in their calculation?

A No, it's a longer period of time.

Q I see.

What is the period of time that Weber and Lajoie are utilizing? If you are aware?

MR. NORTON: Excuse me. Is this from the abstract or from personal memory? May we tie that down?

BY MR. FLEISCHAKER:

Q Well, from whatever source of information that you might be aware.

A (Witness Hamilton) Well, I think I can only state what the abstract says. It corresponds with my general impression of the work that they have done.

Q And what is that?

A And that is-- Well, there are two different numbers mentioned. One is 120,000 plus or minus years. The other is 200,000 years.

Q Okay.

Now the figures .63 to 1.3 centimeters per year, which of the periods applies to that?

eb5

A Well, I believe that's all in the same abstract. It is all talking about somewhere between 120,000 up to 200,000 years that they're working with.

Q Let me see if I can read this. It says here:

"The estimates of average rates of offset on the three primary traces near Ano Nuevo during the past 200,000 years are: --"

I fail to understand your association with 120,000 years.

A Well, earlier in that same abstract it mentions that there are eight traces which offset the first marine terrace which is 120,000 years. So that's evidently one of the things that they are also considering.

Q Okay, but the calculations here, the average slip rate, .63 to 1.3 centimeters per second is calculated for a 200,000 year period. Is that correct?

A That seems to be what the abstract says.

Q Okay.

But you have made no such analogous or comparable calculations?

A No, I've not calculated slip rate at that area that is restricted to that span of time.

Q Do you have an opinion on this slip rate?

A Well, I have not had an opportunity to review in any kind of detail the evidence that they are using. I

eb6

think that it is clearly much in excess of the long-term slip rate of the San Gregorio Fault, and the relationships that I have seen exposed along the San Gregorio Fault near Point Ano Nuevo would not suggest to me that the rate of slip is that high.

Further, if the rate of slip was as high generally as these numbers, then I think that we would see more in the way of such things as cultural offset or offset of triangulation nets where no offset has in fact been observed along the trace of the San Gregorio Fault.

Those factors suggest to me that these numbers that are cited in the abstract may well be high.

Q How about current seismicity?

A The level of current seismicity or the level of known historical seismicity along the San Gregorio Fault I think has been low enough that one would not necessarily see any detectible rate of slip going on.

Q How many magnitude 6 earthq uakes have occurred on the San Gregorio in the last century?

A I'm only aware of there having been one or two shocks and I can't remember now whether it was a double shock in Monterey Bay or just one. That's my recollection, and here I am getting into speculation that people don't like. There may have been a very poorly defined shock in the last century that could have been of that magnitude and could have

been on the San Gregorio Fault.

Q You have no recollection of two magnitude 6 events in the 1920s on Monterey Bay?

A Those are the ones on Monterey Bay and that's the one I wasn't sure whether it was a single or a double event thought to be in the magnitude 6 range.

Q Is it your testimony that that kind -- that level of seismicity doesn't correlate with a rate of slip equivalent to the rate of slip calculated by Weber and Lejoie?

A Yes, that is my testimony.

Q The bottom line is you don't basically agree with the Weber and Lejoie calculation of 1.3?

A I think it's my opinion that that's an unlikely figure, given all the evidence that I'm aware of.

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Q Since you haven't done these calculations yourself, and since, as you have indicated, you are not familiar with the evidence that they've drawn on:-- We've talked about the level of seismicity. What other specific-- What else do you base your opinion on?

A Do you mean my opinion regarding the validity, or the probable validity of the figure of 1.3, or something in that range?

Q 1.3 at the maximum -- as the maximum estimate of the rate of slip.

A Okay.

I look at the long term rate of slip, which appears to me to be more nearly described as one-tenth of 1 centimeter per year. I look at the data reported from analysis of triangulation nets across the San Gregorio fault, which showed essentially no detectable deformation or right slip over at least a 16-year period.

I considered the evidence that cultural features are not offset; whereas, for example, in the 16-year period if we were having 1.5 centimeters per year we would expect to see a one foot offset, about 25 centimeters, over a 16-year period. And over the period cultural features have existed in the region where the San Gregorio fault is on shore. We would expect to see several feet of accumulated strain. We would expect to see the same kinds of deformation

wb2

that one ifinds on the Hayward fault where roads are offset, buildings are broken up, and things like stone walls are deformed.

I think that the lower rate of slip that is indicated for the long term is actually quite adequate to account for the observed offsets of terraces that I have examined in the region around Point Ano Nuevo.

Q Let me-- I'm sorry; have youfinished?

A I think that has summarized the major factors that enter into my judgment that I would not place a lot of credence in this number.

Q Okay.

This .1, for what period is that?

A On the order of 10 million years.

Q By what method could you convert that so you could come up with a figure that would be -- that would apply to a 200,000 year time span?

A I think division would be appropriate.

(Laughter)

Q I would have thought so, too. But geologists work in strange and mysterious ways.

Well I don't want to do the division. Will you do that division for us, please?

A Mr. Fleischaker, we come up with 200 meters in 200,000 years.

vg3

Q What does that come out to in centimeters per year?

A One-tenth centimeter per year, if our arithmetic is correct here.

Q You've indicated there's a triangulation net across the San Gregorio; correct?

A That's my understanding from reading the article describing it.

Q Are there-- Do you have experience in triangulation?

A Not in geodetic triangulation. I'm relying on the scientific discussion in an article for the information I present on that issue.

Q Which article is that?

A This is the article by Coppersmith and Griggs.

Q Mr. Willingham, do you have experience in--

A (Witness Willingham) No.

Q Then I guess neither of you can tell me whether these triangulation nets have been up for a sufficient time to yield results with confidence?

A (Witness Hamilton) I can certainly tell you that 1.5 centimeters per year works out to about 25 centimeters, or about 1 foot in the 16-year period that is reported for this triangulation net. So that even a second order triangulation net should certainty detect deformation of that

wb4

magnitude in a 16-year period which allows for that much accumulation of offset at that rate.

Q You're relying on this article by Griggs and Coppersmith for your information on the triangulation net; right?

A Yes. I haven't examined the figures myself.

Q Do they have an opinion as to whether or not this second order triangulation net has been installed for a sufficient amount of time -- that is, whether this 16-year period is sufficient to show the strain rates that Weber and Lajoie have--

MR. NORTON: Excuse me, Mr. Bowers. I'm not sure that there was any testimony that it is a second order triangulation network. There may be. I know Mr. Hamilton used that phrase, but I don't think -- I don't know that he used that phrase in connection with this triangulation. I think he said "even a second order," and there may have been an implication that this was a second order as opposed to a first order. I don't even know the difference between the two, but I would like the record straight.

BY MR. FLEISCHAKER:

Q What is your information as to what order triangulation net this is?

A (Witness Hamilton) I can only quote the article which says,

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"Because the triangulation precision is only second order and most of the time periods are relatively short, this data is probably not capable of showing strain rates comparable to the long term geologic rate of fault offset of about 1.6 centimeters per year. (Weber, oral communication)."

I am sure we have looked at the dimensions of the triangulation net that accompanied -- in the figure that accompanied this article. And it's my opinion that the 1 foot that should have developed along that fault during that period of time should have shown, if the rate was going at 1.6 or some likely figure per year.

Q You have a different opinion from Coppersmith and Griggs?

A Yes.

Q Okay. And what is your experience in triangulation nets?

A Well I know how to operate a transit. I can turn angles. And I'm somewhat familiar with the procedure that one goes through in ordinary surveying. I have not spent time in analyzing geodetic nets. In this case I believe they are taking U.S. Coast and Geodetic Survey data and making an analysis of it.

Q I take it also that you likewise haven't operated

wb6

a net or assisted in the operation of a net?

A No.

Q What is a creep meter?

A My understanding is that it is a device that can be, or an instrument that can be located across an area where some kind of deformation is expected. And the amount of deformation that occurs will be recorded by that instrument.

And I think that that can be done by several different means. And I'm not personally familiar with the operation of such instruments or the techniques used.

Q What is an alignment array?

A Let me turn that question to Mr. Willingham. I think I have an idea but I would rather not guess.

A (Witness Willingham) Well, an alignment array is sometimes referring to a sequence of markers strung perpendicularly across the fault. You come back periodically and survey these markers to see if they have shown any substantial displacement.

Q Do you have any information as to whether creep meters or alignment arrays have been installed on the San Gregorio?

A (Witness Hamilton) No, I don't have any such information. I'm not aware that they have been; except insofar as one can consider roads and fence lines, features like that,

wb7

to be a sort of crude type of alignment array or creep meter.

Q You also indicated that you are not aware of any offset cultural features.

A That was my testimony.

Q All right.

What studies, if any, are you basing those conclusions on?

A The article that I'm making reference to here.

Q What does that article say about offset cultural features?

A It says,

"Fault creep has not yet been observed or measured along traces of the San Gregorio fault zone. Field mapping investigations to date have not discovered evidence of offset cultural features. (Weber and Lajoie. Personal communication. 1977)."

It goes on to say,

"Detailed or systematic studies have not been made."

Q Dr. Jahns, I would like to ask you, What is your opinion as to the amount of accumulated offset that has occurred on the San Gregorio fault zone?

A (Witness Jahns) Would you repeat that question, please?

Q I'd like to have your opinion as to the amount of

vb8

accumulated offset that has occurred on the San Gregorio fault zone, both vertical and horizontal?

A I have very little in the way of a meaningful opinion concerning the vertical component. But for the horizontal, a few kilometers. If you're referring to what has become our standard period of reference, the last five million years.

Q How about for the last 15 million years?

A I wouldn't offer an opinion on that. I don't think it's really pertinent here.

Q Is that to say you have no opinion?

A That's fair. I offer none.

Q Mr. Hamilton, your opinion as to 10 or 20 Km, my recollection is that that goes to 15 million years; is that correct?

A (Witness Hamilton) On the order of 15 million years, yes. It's approaching the age of the volcanic formation that we find on both sides of the San Gregorio fault and the general age of the sedimentary basins that give rise to the gravity anomaly which seems to be offset by about 10 kilometers right slip.

It's also somewhat older than the age of the rocks near the Serra Hill fault.

Q Dr. Jahns, in your testimony at page 4401 of December 6th, 1978, you refer to the work of Graham and

wb9

Dickinson.

A (Witness Jahns) Yes.

Q --that is published in Science Magazine, and to the hypothesis which they have.

Very shortly, what was the hypothesis that they propose with respect to horizontal offset on the San Gregorio?

A Well their hypothesis involves a very large cumulative offset in a right lateral horizontal sense over a long period of geologic time, several tens of millions of years. They cite several kinds of evidence for this, some of which, on close scrutiny, turns out to be permissive rather than requiring, and some of which turns out to be very encouraging, almost requiring, but involves very old features and, hence, does not tie down the possible period of major movement.

Then to that can be added what in my opinion is a very neat attempt to explain the apparent discrepancy in cumulative offset along the northerly reach versus the southerly reach of the San Andreas fault by means of, in effect, plugging in major offset along a San Gregorio and southward trend. This doesn't fully do the trick, just in geometric terms, as pointed out last year. But it is an ingenious attempt to explain an apparent discrepancy that has prompted investigators to look for an ancestral San Andreas fault in the southern part of California.

wb10

Q Dr. Jahns, do you have a recollection as to whether or not Professor Dickinson and Dr. Graham concluded that the majority of the right lateral slip occurred within the last 15 million years?

A Yes. I have at least three recollections of this, all in contrast. And I can report them if you wish.

Q Would it be helpful if you were to refresh your memory by reference to the Science Magazine, or would it be helpful if we were to refresh your recollection by reference to the Science Magazine article?

MR. NORTON: Excuse me, Mr. Bowers. He didn't say he needed to refresh his recollection at all. He simply asked if Mr. Fleischaker really wanted an answer to that question on three fronts.

MR. FLEISCHAKER: I'll take them.

MRS. BOWERS: If you're starting on what will amount to a considerable time in cross-examination, you may have heard Dr. Martin's five o'clock alarm go off.

MR. FLEISCHAKER: Let's hear the answer to this, and then I think we can probably quit.

WITNESS JAHNS: I can make this brief.

There are three phases, so far as I am aware of personally. The first time I heard this presentation was in Sacramento. And at that time the implication presented by Steve Graham, who gave the paper orally, was to the effect

wb11

that probably most of the indicated, or inferred accumulated slip occurred early, during the last 30 million years or so.

Phase 2 was my first reading of the Science paper, in which something approaching the opposite impression was created. The impression with which I was left was to the effect that a pretty good chance that most of this occurred late, including the last five million years, in the history.

Phase 3 is the most recent paper published as a part of the California Division of Mines and Geology special paper in which, in effect, the authors contradict themselves. They come out with a very clear statement, to which I completely subscribe, relative to 6 centimeters per year of average rate of plate movement. And then they clearly state that for the past six million years nearly all of that plate movement has been accommodated by slip along the San Andreas fault. Yet they retain parts, significant parts, of the Science article in this more recent article published in '78.

This is why I say it is somewhat contradictory. But they have a brief discussion, beautifully illustrated by a diagram somewhat similar to the diagram that is in the applicant's direct testimony to this point. And their conclusion is that nearly all of the plate boundary movement in the last six million years has been accommodated by slip along the San Andreas. And that leaves nothing but crumbs

wb12

for the other faults.

MR. FLEISCHAKER: Well I'll have to let the article stand for itself. Mr. Graham will be here. But my question went to the 115 Km of offset and the period when that occurred.

BY MR. FLEISCHAKER:

Q Is there consistency between the observations in the Science article and the most recent publication in the CDM Report No. 137 that most of that offset occurred in the last 15 million years?

A (Witness Jahns) I think that is a consistent message.

MR. FLEISCHAKER: No further questions. That's it for the day.

MR. NORTON: Mrs. Bowers, I have a couple of legal points. Perhaps if we could -- Maybe the witnesses and so on could go back. But I have maybe, you know, a couple of things I would like to get a ruling on, rather than take up an hour or two in the morning. It might be a good time to argue it now when we're constrained by time.

MRS. BOWERS: Have you attempted to discuss them with the other parties?

MR. NORTON: Yes. One of the things is something we discussed before. It has to do with the panels. And the other has to do with order of presentation of the cases, which

wbl3

I have discussed with Mr. Fleischaker before and we didn't reach agreement on. But it does bear on the hearing order.

MRS. BOWERS: Well why don't you proceed?

MR. NORTON: All right.

MR. FLEISHAKER: Mrs. Bowers, I'm not quite sure what we're in for at this point. What I would propose is that we sit down and see where we are on this, and maybe we can take care of it in much quicker form tomorrow morning at eight-thirty.

MRS. BOWERS: You had a ruling on the panel.

MR. FLEISCHAKER: The Board was permitting it and I had a standing objection.

MR. NORTON: I just wanted to be sure we did have, because we have people coming in and I don't want them sitting here for days waiting to get up there and find out they are here for nothing. That was my primary concern about the panels.

My second point is that, in Mr. Fleischaker's schedule we did discuss that, but there was one day on his schedule that we didn't discuss. It involved the tail end of the schedule. And I'm going from memory: I don't have it in front of me. But I believe it is -- I now have it in front of me.

Here it is. It shows on the 18th of January--

MR. FLEISCHAKER: Optimistic.

wb14

MR. NORTON: Very.

(continuing) --the testimony of Mr. Knight and others. And then on the 19th it says "Rebuttal, applicant." And then on the 22nd it says "Rebuttal, intervenors."

Now if that's the case, it's a new one on me. I understand that the applicant has the burden of proof, which means he goes first and he goes last. But after he goes last the intervenor doesn't come along with rebuttal testimony. And yet that's what this schedule shows. And if that's the basis Mr. Fleischaker is operating under I don't want to go through to the end of the hearing and have him suddenly say "Oh, my gosh, you mean I can't have rebuttal? Gee, that's when I was going to put on this, that and the other thing."

And I would like to have a ruling from the Board now as to the ordering -- or in the morning, if you want to talk it over this evening -- as to the order.

It's our position that applicant is not entitled to rebuttal at all; his rebuttal comes at the same time -- excuse me; the intervenor: let's clear that up on the record, Mr. Bloom. The intervenor's rebuttal comes at the time he puts on his direct, because we'll have finished. And that's when he puts on his direct and rebuttal. He doesn't wait until everything is done and have the last bite at the apple. That's totally inconsistent with the burden of proof notion

wbl5

of hearings.

MRS. BOWERS: You said-- I don't have it in front of me. But you said January 18, 19 and 20. Is that December or January?

MR. NORTON: No, that's January. It's Mr. Fleischaker's January schedule. We have yet to see his February schedule.

(Laughter)

MR. FLEISCHAKER: I invite you all to join me. May I reply?

MRS. BOWERS: Go ahead.

MR. FLEISCHAKER: Mr. Norton's argument flies in the face of the clear language of the regulations. The language is absolutely clear on this, and I don't think there is any doubt. 2.743. Evidence. Subparagraph (a). General. It reads as follows:

"Every party--" And it doesn't say "except intervenors." It says,

"Every party to a proceeding shall have the right to present such oral or documentary evidence and rebuttal evidence, and conduct such cross-examination as may be required for both full and true disclosure of the facts."

And I read that to mean the intervenors have the right to rebuttal evidence. And I am unaware of a legal

wb16

interpretation that means that a direct case and rebuttal are one and the same thing. That's what Mr. Norton is arguing. And that is a unique argument indeed.

MR. NORTON: Mrs. Bowers, let me very quickly respond.

That's not what I'm arguing. They have the right to put on rebuttal testimony, but they do that immediately after they put on their tdirect testimony. Because we've finished at that point when they go on. They don't get to put their rebuttal on after we do, because we go first and last, because we have the burden.

And I'm not saying they don't have the opportunity to put on rebuetal. It's a question of when. And when they put it on is certainly prior to us.

MRS. BOWERS: Well we understand your position.

Does the Staff have a position on this?

MR. TOURTELLOTTE: Well generally I would, I guess, tend to agree with Mr. Norton. Mr. Fleischaker has the right to put on rebuttal testimony. But presumably he has a direct case and he has filed that direct case with us. And after that direct case is put on, if anything has come up during the course of the hearing that requires that he answer additional matters, then he should put on his rebuttal case then.

And I do agree that the applicant goes first and

wb17

last. Exactly when Mr. Fleischaker puts on his rebuttal testimony inbetween is not of any particular significance.

MR. FLEISCHAKER: Can I reply to that?

That's the craziest thing I ever heard of.

MR. NORTON: Excuse me, Mr. Bowers.

If Mr. Fleischaker wants to assume the total burden of proof he can change the law and assume that burden of proof and then he can go last. But until the law is changed and the burden of proof is taken off the applicant's back there's no way that anybody but the applicant goes last.

MR. FLEISCHAKER: In the proceedings in which I participated -- Seabrook and also Indian Point -- the way this was handled was as follows:

Each of the parties went in the order applicant-intervenor-staff. And then there was a simultaneous filing of rebuttal testimony. And at that point everybody went in the same order: applicant-intervenor-staff, with the staff batting clean-up. And that's normally the way it's done, as I understand it.

MRS. BOWERS: Now wait a minute. Let me listen to that again. You're talking about first the direct case.

MR. FLEISCHAKER: That's correct. And then there's a simultaneous filing of rebuttal testimony. And--

MRS. BOWERS: Following cross-examination.

wb18

MR. FLEISCHAKER: Following the cross-examination of all parties. You have applicant-intervenor-staff.

Thereafter a simultaneous filing of rebuttal testimony. And followed by the same order: applicant-intervenor-staff, with the staff batting clean-up.

MR. NORTON: Excuse me, Mrs. Bowers. We have Mr. Geer here who has probably been involved in more NRC/AEC proceedings than anybody alive today. And I'd like to have him comment.

Did I say that wrong?

(Laughter)

In any event, you know, I'd like to have his comments on that. Because I think Mr. Fleischaker is just dead wrong when he says that.

And, you know, I'm not going to say I've attended this many or that many hearings and make a count as to who has attended most. But I know Mr. Geer has been involved in this since it started, for the last twenty-some years now. And I think what Mr. Fleischaker is suggesting is not done.

MRS. BOWERS: Well I think we know the position of the parties. So we'll consider it through the evening break and plan to reconvene at eight-thirty tomorrow morning.

(Whereupon, at 5:15 p.m., the hearing in the above-entitled matter was recessed, to reconvene at 8:30 a.m., the following day.)