DIET AND HEALTH IN PREHISTORIC CALIFORNIA: Lifeways of the Ancestral Ohlone

Insights from Stable Isotope Analysis of Human Bone from the Yukisma Mound

Presenter: Karen Smith Gardner, CSU, Chico Anthropology Graduate Student

Dr. Antoinette Martinez, CSU, Chico Anthropology Department Chair: Today we're very -- I'm very excited to have Karen Smith Gardener, one of our grad students, one of our current grad students. And she's doing me a favor by not finishing up this semester. She did it for me. She's going to wait until next semester.

Karen Smith Gardner: You're welcome.

Dr. Antoinette Martinez: She's going to be -- well, we have a title here: "Lifeways of the Ancestral Ohlone: Insights from Stable Isotope Analysis of Human Bone from the Yukisma Mound (CA-SCL-38)." And she's already given a presentation today. She did a presentation for my California Archeology and Pre-history class, emphasizing the artifacts and how her research is providing support for the interpretation of these artifacts. Not only at her site but in California. So I think the research that she's doing is very impressive. And so let's move on and let her talk about her research.

[Applause]

Karen Smith Gardner: Thanks, Anne. Thank you all for coming. I am glad to be here to talk to you about the preliminary findings of my thesis research. Today I'm going to be giving you a synopsis of what I've done so far with the data I've been privileged to work with. And the content includes information I presented during the past five weeks at three conferences: the Society for California Archeology, the Society for American Archeology, and the American Association of Physical Anthropology. So if you've attended those, I apologize, some of this may be familiar. And if you haven't, well, either way, thank you for coming. So I'm part of the issue series, I guess. I'm not speaking about the Yahi. The group I will be speaking about is a little bit further south at the Yukisma Mound in Santa Clara County.

This is a general outline of where we're going to go today. I'll start by talking about the site itself and then I'll describe my methods, stable isotope analysis. Chemistry is fun and interesting – we'll play. Then I'll address a few questions about the dietary patterns of this population. What's on the menu there, what are they eating, comparing that group with other local groups in the region. And then looking at variation within the site, within the population there, by sex, by age, looking at some of the mortuary regalia, the arkers of social status and social roles. Then we'll talk about breastfeeding and weaning, and finally there's some mystery men at the site. And I'm excited to show you a little bit about them, and I would be interested to know your interpretation of who those people might have been. So we have a lot on our plates. Here we go.

The site itself, Santa Clara 38, is about 159 miles, almost due south of where you're sitting right now. There's Chico, the wildcat. So just south of there. It's about six miles inland from San Francisco Bay. And there are several other important sites in the region. And so we'll look at how this fits within that setting. The location itself is now within modern day Milpitas, and within the grounds of Elmwood State Penitentiary. So I haven't done a site visit, needless to say. But the site was excavated in the early '90s. They were expanding the prison and they called in the CRM, firm of the [Inaudible] Maloney to do the excavation. So the Maloney family consulting services was responsible for all the work down there. Before I go any further, I do want to let

you all know I've included some photos that have human remains in them in this talk. They were provided to me by the tribe for these purposes, for educational purposes. So I have their blessing to use them and hopefully you don't mind.

And here they are. So here's a photo from the excavation. The excavation happened in 1993 and 1994, and the remains were above ground for about six months. They were examined at San Jose State University by Bob German and a team of osteologists. And then most everything was repatriated. Put back under ground with ceremony and reverence. However, many of the artifacts were kept above ground, and are housed now at San Jose State University, and also are being used by the tribe in their educational displays and that sort of thing.

And finally, with a lot of great for sight, they elected to save out one rib from each individual where it was feasible to do so. So for 202 individuals we have a rib still above ground that is for the purposes of research. And with those ribs there's ancient DNA research going on right now up in Washington State. The stable isotope analysis research that I'm doing is done with those ribs, we have obtained some new carbon 14 dates, and we still have some material left over. It doesn't take much to do this research. It's a very unique and special agreement we have with the tribe and I'm just really grateful that they've privileged us with this access to information about their ancestors.

So I mentioned that we've done some additional work with dating here. To understand the context of this site we've looked at all of the available dating resources, beginning with diagnostic beads. Different sorts of shell beads have been linked to periods in time. So starting with that, we have 41 individuals with beads that are diagnostic. Of those, some appear to go almost 4,000 years into the past. Later, those same individuals have been dated with other methods, like obsidian hydration or area carbon dating. And as a result of that they have been -- these dates have been moved more recently into the middle, late transition. Obsidian hydration dates of all of the obsidian available from this site have been entirely in the late period or so. There were some early radio carbon dates in the '90s, and then I got to run some radio carbon dates last year. The ones I ran, I re-tested this really old guy, because he was suspicion to me. It was just odd to see something that old. And I retested this one as well, was just too modern. Both of these were moved into this little time span right there when I tested them again. Methods have changed a bit since '97, so I would credit that. And I don't know about this, I would be curious to retest that as well. But the one thing I do know is that when you put all of that together, all of the various methods agree that this site was primarily used during the middle late transition and the late period. So about 800 to 250 years ago.

It's a little blurry. What really impressed me about this site when I first got the opportunity to work with it is that there's a lot of great context there, the tribes been involved, and as a bio-archaeologist, I was curious about the kinds of stories that those bones that they saved out could tell us about the past. And in particular, I was interested in social identity and social organization. Lowell John Bean commented about the Ohlone that they were peculiarly complex hunter-gatherers. And looking at markers of social identity and that sort of thing through the idea of diet really intrigued me. Because ultimately, we are what we eat, even socially. And when we observe social organization around us, we internalize it, and even if we're not told this is what you should eat and this is what you shouldn't eat, we'll internalize what we see in practice. And that practice is called doxa. By Pierre Bordeaux. He calls that dietary doxa. An example might be if you were to host a party of people to watch a hockey playoff game, and you were to host a book club, you could serve the book club the chili cheese dip and Fritos. You could serve the hockey players chocolate-dipped strawberries. But you probably wouldn't. And it's not because

you couldn't, but you wouldn't go there. I -- I'm saying I wouldn't go there. Perhaps you would. I don't know your friends. But you internalize the kinds of things that are appropriate to different social roles, social settings. And that's how you practice them. My idea was that the people of the past would have done the same. And my tool to investigate this was stable isotope analysis.

Okay, here's comes the chemistry. So what are isotopes? Isotopes are atoms of an element. They have the same number the protons but a different number of neutrons. And you can see here we've got three elements represented. The red dots are the protons. The number of protons is always the same, that's what makes an element what it is. The number of neutrons can vary. And those are isotopes. Some isotopes are stable. They're just fine as they are. Some isotopes are radio isotopes. They're unstable. Things like carbon 14 is a radio isotope. And over time, it will change into something more stable. Today we're really just concerned with the stable isotopes. Of which there are many.

This is a periodic table that shows you all of the elements. And above each one all the atomic rates of stable isotopes that exist for those elements. It's a little overwhelming. But the good news for you is today we care about this one and that one. Carbon and nitrogen. Just those. Carbon has six proteins. Always six proteins. That's what makes it carbon. But there are two isotopes of carbon that are stable. 12, which is the most common. 98.9 percent of all carbon in the world is carbon 12. It has 6 neutrons. And there's 13, which has 7 neutrons. Nitrogen has 7 protons, two isotopes, 14 with 7 neutrons, and 15 with 8. And as these go through systems they can inform us about dietary patterns. We'll see

So the stable isotopes are naturally occurring. The ones with the extra neutrons, they have extra stuff. They're a little bit heavier. They'll move through systems a little bit more slowly, they'll bond a little more strongly. The way that they react is slightly different and that helps us trace their movement through these ecological systems. When we talk about stable isotopes we report the heavy relative to the light. The light's usually more common and the heavy is more rare. So it's a ratio of the two, and we compare that to a known standard because these are tiny, tiny little numbers. And to make them more manageable we compare how much is in our test subject with something we already know about. Then we measure it in permill. Which is a ratio that just, again, makes those numbers easier to manage. The values within a living thing will vary based upon metabolism and environment, and the ratios in foods get passed along to the consumers.

So literally, we are what we eat. And as we think about this, this is my fun fact of the day, every particle that you are made of, you sitting right there, every particle you are made of has been on Earth since the beginning of Earth or it came from outer space on a meteor or something like that, in the meantime. All of that matter that exists on Earth is made of these atoms that just keep getting recycled in different shapes and different forms and that sort of thing. So when we build our bodies, we're building them out of the foods we're consuming. And bone, which we think of as being pretty sold and unchanging, actually changes all the time. It's being torn down, it's being built up, constantly remodeling. In children, infants, that bone turns over entirely within a year. In adults, within 10 to 15 years, everything is new again. There is nothing inside of any one of you that was there 15 years ago except your teeth. Once you grow teeth, they're yours to keep, they don't remodel. But everything else changes all the time. And it's built out of what you eat. So that makes it really helpful for us to look into the past and understand dietary patterns.

When we look at bone, bone is made up of proteins and mineral, the protein gives it resiliency, the mineral makes it strong. And also tell us different things about diet. So the present component, mostly collagen, and that's what I'll call it for the rest of the presentation, it's built

from amino acids, and those amino acids come straight from dietary protein, why reinvent it if you're consuming it already? So bone protein will mostly tell you about the dietary proteins. Bone mineral, hydroxyapatite for the chemists in the group, is again what makes it hard. And what's interesting to us there is that the carbonate which substitutes into that hydroxyapatite comes from the carbonate in blood. That's built from the whole diet. So bone mineral, when we look at that part with isotopes, is going to tell us about everything people are eating, not just the protein. You put the two sources of information together and it's informative about past patterns.

So what do we do with these things? Well, we clean them up, the bones, we mechanically clean them and then chemically clean them. We isolate either the collagen or the apatite to study, and purify them. Then we send them to a lab with a mass spectrometer, a fancy machine like this. And they tell us about the isotopic ratios. Mass spectrometers are cool. So you'll have to indulge me just a little bit. The sample is ionized and the ions are shot through this tube. And there's a magnet in there that's so strong it can separate out the difference in mass between those tiny little particles. So that it can count out the quantity of the heavier isotope versus the lighter isotope. But we do all of this at Davis and they tell us the answers.

Okay, so carbon. I told you carbon and nitrogen are our two. Carbon's always got six protons, different numbers of neutrons, and the main purpose of looking at carbon for us here is to tell terrestrial from marine resources. Terrestrial resources in a biological system, they're given the carbon from atmospheric carbon dioxide. Through photosynthesis, the plants breathe in the carbon dioxide, they keep some of that carbon, then consumers eat those plants, and it gets passed along through the system. Those low values get passed through. There are different kinds of plants that would give us different signatures. But they don't grow here. Everything in California has very low ratios. Negative 20 per mill to negative 34 per mill. So quite negative. Whereas marine values are higher because the source of carbon there is different. Carbon in sea water is about 0 per mill. So it's a 7 per mill difference just to begin with. These will be closer to 0, more positive values.

Nitrogen is the other element we're going to look at. It's a vital component of amino acids, which are part of proteins. And so it will tell us about the protein in the diet and we've already reviewed 7 protons in that nucleus, 7 neutrons, most of the time. Sometimes 8. So nitrogen, the heavy isotope of nitrogen accumulates in trophic systems. Each level, we see about 3 per mill enrichment over the earlier levels. So in plants we have a low number. The rabbit eating the plants, about 3 per mill higher. The human eating the rabbit, it's about 3 per mill higher than that. Terrestrial systems have fewer trophic levels. Marine systems have more. You have lots of different sequences of critters eating bigger critters eating bigger critters, so they end up with higher hydrogen values. But another fun thing for us is that breastfeeding infants are a trophic level above their mothers. So we'll see a 3 per mill or so enrichment of nitrogen for breastfeeding babies over a human mother. And that's going to come in handy as we go on.

Okay, this will tell you something about the sample that I selected. There were about 248 individuals exhumed at the site. 202 ribs were kept. I selected a sub sample of that, 126 individuals it ended up being, to represent the diversity of the site as best I could. So I had 57 males 38 females, 7 adults of indeterminate sex, and all the sub-adults I could. 24 were available out of 42.

What could be on the menu? Well, when we look at ethno-historic sources, paleo-botanical sources, residue analysis, pollen analysis, all the various sources we have, the hundreds of plants that these people probably used. Isotopically, they all look the same. So we can't learn too much there.

But when we look at the fauna, there's a lot of variety here. You can see there's terrestrial animals that are herbivores, they're omnivores, they're carniovers. We'll see increasing nitrogen through those systems. There's marine resources. Again, with increasing trophic levels over there, there are birds. Each photo here represents a species specifically found at that site. The one exception is the fish who is there to represent all fish. It is an all-representative fish, because I had not been able to locate any analysis of that particular species that were utilized there. There's very little fish remains, in fact, at the site.

Okay, so finally we can look at the distribution across the population, now that we've done the chemistry part. What this is, is showing us is the difference between the values in the collagen, the protein part of the bone, and the apatite, the mineral part of the bone. And essentially, this is a model that tells you. Over to this side will be more terrestrial protein, over to this side it more marine. And you can see, looking at it, this group in general is mostly eating terrestrial foods. Back on this picture, that's most of what you saw here, isn't it? Mostly terrestrial. So not a surprise, but good to quantify.

This is a more recent model, does the same thing, and by golly, it's showing us the same answer. Terrestrial, much closer to the terrestrial line, further from the marine line. So mostly terrestrial foods being consumed by these folks. This lovely graphic, thank you to Dr.(Eric) Bartelink for the preliminary research to make the boxes, which is a whole lot of work, shows you where they fit in the larger food web. So each of these boxes represents the isotopic variation of these different species. Down here we're seeing the carbon in the dung collagen. Here we're seeing the nitrogen in the bone collagen. So trophic level up here, this is more of the marine terrestrial line. And you can see, marine species, they're higher in both carbon and nitrogen. Terrestrial species are lower in both carbon and nitrogen. And everything else is sort of on the gradient between. These people here are eating foods from this entire menu, probably. What you're seeing is the bulk average of what they've eaten over the last 10 or 15 years. But mostly, or you can tell me what are these people eating, are they eating a whole lot of marine food? No. Maybe a little bit. Especially these folks here. They're eating quite a lot, probably, of freshwater fish, probably some terrestrial herbivores, maybe some terrestrial carnivores, although I've heard they're not very tasty. But I don't want to judge. And probably some marine fish as well. Bay shellfish, definitely a component. So that situates them pretty well within that web. But the next thing that would be of interest would be how do they compare to other populations.

Well, looky here. This makes me happy. This is a population at Santa Clara 38 compared to 22 other populations that were in the area. And again, thanks to research from Dr. Bartelink and Melanie Beasley for this comparative data. But here you can see, based on where these sites were, the purple are Marin County. That's the North Coast. And by golly, they're eating a lot of marine foods there. The blue is San Francisco Bay. Some marine, maybe a little less. Down here we have the South Bay, the red which is where my group falls. And above in the brown is Sacramento Valley, yes? No, Delta. No, Sac, sorry. Brown is Sacramento Valley, the green is the Delta. They're eating a little more freshwater fish, it would seem. They're getting a higher trophic level here, but it's not marine, because you're not over there. So here this population is perhaps a bit enriched compared to the other sites in the area. Not statistically different. But it's about 0.4 per mill enriched, the average, over these others. So perhaps there's something going on there. You can see how it all fits.

But now we're back to this. And I want to return to my original questions about identity, food and identity, and what can stable isotopes tell us about who these people were, what kind of patterns are we seeing within the population.

So the first question I asked was am I seeing correlation between diet and age. Do you earn your right to eat different foods, are there foods for children and foods for adults and foods for older people looking at this pattern here, I've taken the infants out for reasons that probably become obvious later, because they have a pattern. But do you see any pattern by age? Any groupings of colored dots? Not a whole lot. Statistically speaking, no. There's no correlation by age. And this is interesting, because when we think about status in the area, status is said to be ascribed. It's said to be something that you're born into. And if you're born into it, there's no progressing through different statuses by age, you'll be born to whatever it is. So you're not seeing correlation with age.

But my next question was sex. Am I going to see any kind of pattern by sex? And looking at that array of dots I imagine you can say yup, there's definitely a pattern. I'm seeing more males up here, more females down here. But there's a lot of overlap. Look at these females all the way up here. Look at these males all the way down there. Sex doesn't explain everything, and that's interesting as well.

In fact, when you look at the distribution by sex, you can see there's overlap of almost the full range, and sub adults cover the entire range of males or females in both the carbon and nitrogen.

So now I'm curious about context at the site. Several of the burials, 21 of them involved cremations, or pre- or post-internment fires. And I thought, well, that seems like something you would do for people of certain statuses or identities. But no, it doesn't correlate with diet at all. Interesting.

Projectile points. Again, 21 people, but not the same 21 people were associated with projectile points, either embedded in them or associated with them. But those weren't significant at all, as far as that. So the idea that perhaps there was a warrior class that might have had different foods -- not at all. That's not what we're seeing.

But perhaps there's some other associations with the mortuary regalia, the amazing material culture we're seeing from the site. They had some very impressive, enormous ground stone pieces, bone tools, charm stones abalone pendants, [Inaudible] pendants up there. So let's see what we see.

Well, I looked at the association with beads and sure enough there is some significance there. Beads in general, presence or absence made a difference. And beads have been associated as markers of status or wealth. So that makes some sense. But when I broke it out to types of beads, and I was limited a bit by beads that had presence high enough for statistical significance, if there were more than 24 individuals with a certain type I was able to run this test, an independent T test. Type A1a beads were significant. It made a difference, if they had them, people had them, and they had different diets than people who didn't. But A1b beads were not. Now interestingly, when A1a beads are temporally significant, they're associated with either the early period or late period one, whereas A1b beads are not associated with any particular time period. So that could play in as well.

These abalone pendants, which are probably associated with moieties, or clans, the kin-based groups. Everything I've read says they're very important for status and that sort of thing, identity. They weren't quite statistically significant, but they're approaching significance at P equals 0.05, that would be a 95% confidence range. These would be significant if you extended that to say, a 93% confidence range. So, pretty close.

Ground stone. Now this one really surprised me. I expected ground stone to be significant, because these things are extraordinary. The work and care that's put into them, of the mortars, there were 23 mortars associated with the site, 20 of them were with burials. 6 were ritually killed, broken. They're big, they're heavy, they're exotic materials, they have shell embellishments on some of them. But no, they're not significant. Interesting. Also, they're not associated with sex, particularly. There's pretty equal distribution of males and females with both mortars and pestles. And looking at them like this, perhaps you say okay, well it's nice, it's a rock. Whatever. But in context, they're really amazing.

Look at these pestles. This male here is buried with two pestles tucked underneath him. This one has one large one extending between his legs. And you can't tell me these are utilitarian objects. They must be significant. But they're not correlated with diet, or at least the identity that led these people to have burials of this sort didn't have any dietary pattern that I can identify associated with it.

So then I looked at artifact types where I have too few for statistical significance, and I plotted them just to see do they cluster, is there a pattern. And I have no pattern at all for bone whistles, bone awls, mortars, pestles, stone pipes.

But I did have a really lovely cluster for charm stones. These objects over here are charm stones, and ethno-historically speaking, the idea is that they were part of a shaman's tool kit. That certainly is consistent with what I am seeing. Everyone with a charm stone is right here. They're not at either end, maximum or minimum of the possibly range of variation, but they're very specifically clustered. And that's telling me that they're all eating the same foods off the menu. Shamans are said to have specific dietary and guidelines and taboos. So that certainly is consistent there. Interesting.

Okay, so finally, let's talk about the people that don't fit the pattern very well, the outliers. There's really two groups going on. First I see all of these sub adults flying up here in the sky. And then I see these four little boxes down here that seem to be on a different line all together. As we're looking at these I've got a hypothesis that these sub adults are enriched because they're breast feeding. But I wanted to test that a bit.

So first I looked at relationships within the group to see which infants were associated with adults. And I've really just got this one infant associated with a female. But it's dramatic. She's about 19, buried beneath a mortar, and on the mortar is a year-and-a-half -- one-and-a-half-year-old infant. Reasonable guess that they're related. And when I compared their nitrogen levels, almost exactly 3 per mill different. So it's only one example, but it is a pretty strong suggestion that this is a mother and her infant, and the infant was breastfeeding at the time of its death.

Here's another infant buried with an adult, but this time it's buried with a male. And I'm not really suggesting the male was breastfeeding the infant, but I'm going to guess since they were buried together they probably are closely associated, maybe related, maybe the adults of the family are eating from the same table. I've made a few jumps here, and I know it. But I'm working with

what I have. And when you compare them you do get the same kind of difference, almost 3 per mill. Interesting.

These two children were buried together. One's about three-and-a-half years old, one's about four-and-a-half years old. Their nitrogen values are almost identical, and also very, very close to the average nitrogen values for adult women in the population. So they seem to already have been weaned. And I'm not seeing that elevation there at those ages. The other two that I had in my study couldn't really be compared. One wasn't available at all and the other was with someone who wasn't available. But it does establish this idea that those elevated youngsters are breastfeeding.

Okay, so on this graph I plotted just the nitrogen values, and you can see here the trophic level separation pretty well. These are values for faunal remains that I tested from the site. They're lower, generally, except the coyote who – if it's like coyotes I'm familiar with – could very well be munching off the same menu as the humans in the area. Here you can see the average for the population, and two standard deviations above and below. I'm definitely seeing some elevated levels here, but then there's some over here as well. And I think we have a few more things to separate out.

Back to this graph. Both carbon and nitrogen are enriched with marine foods. So my solution to the problem of shifting out marine enrichment from breastfeeding was to do a linear regression where I used the carbon value to predict what the nitrogen value would be, given this slope. Effectively, this flattens everything out, and you get this.

In this case, zero is saying that the nitrogen is exactly what would be expected given the carbon. 1 above is 1 standard deviation higher than that, as far as nitrogen is concerned. 2 above is the range of 95% confidence that this person's eating within the same diet, beyond 2 those are the outliers. Now we have a good way to visualize which ones are exceptional. And right here, the very young ones are flying high. These are definitely enriched. But then I've got some down here as well.

So two problems of who is eating from a different menu. We've got our breastfeeding infants. And then we've got the mystery men.

So looking at the infants first, I'm going to spread this area out a bit on this graphic. So now we're going to 7 years old. And what you expect to see with weaning is that when an infant is born it's going to be the same level as its mother. As it breast feeds, that nitrogen level will rise and become more enriched as that bone slowly turns over. When foods are introduced, but aren't a trophic level higher, you start to see the levels fall. And when the infant is fully weaned and no longer breastfeeding it will be in the range of the rest of the population. There's about a six-month delay or so in metabolizing the nitrogen, so everything will be offset just a bit.

So we add a fit line to this, and by golly, if it doesn't look like that. Very nice. So here, again, at birth, this is exactly what we expected. At birth, it looks a lot like the mother's. Then we see this elevation at about 2. And it falls down to within the population by a little after 3 years old.

What we're seeing, then is the introduction of weaning, this is happening about an a year-and-a-half to two years. And breastfeeding is complete by three to three-and-a-half years. This is a little later than expected, compared to the only account I know of, of breastfeeding practices of the ancestral Ohlone, which said that the French explorers in the late 18th century said that Ohlone weaned their children between 18 and 20 months. What we're seeing is 36 to 42

months. So much later, but not unexpected, given the practices of other natural fertility societies.

Okay, so now we're back to the mystery men. And they are almost three standard deviations beneath what would be expected. By any way of looking at this data they really seem to be eating off a different menu. One man is about 16 years old, the others are in their early-mid 20s. And this is them. While most of the individuals at this site are buried with some ceremony, curled on their sides, these men, the first guy in the pit is curled, positioned sort of formally. The other three are flung on top. Randomly positioned. They've got -- they're all young males. Three of them have projectile points, two are embedded, one is associated. And very few other burial associations. There are -- let's see. The first guy had only a few shellfish, the second guy had a couple of pieces of chert – a pebble core and a quarter flake – and a few shellfish. The third had no recorded associations at all. The fourth had one piece of chert – which is a primary flake – a few shellfish, and a bird bone. But really no mortuary regalia like we've seen with many of the other individuals. So who are these folks?

Looking again at this graphic, where we're comparing the population with others in the area, these are our guys here. So we're looking at the means and two standard deviations for each of these other sites in the South Bay. They really don't fit. The only one that they're close to at all is this here, which is the Sand Hill Road Stanford site. But even there, they're at two standard deviations from the mean, they're below the mean. So not real likely they're part of that population. They're a mystery. So I'll come back to possibilities for them. No, I won't, I'll talk about possibilities for them. So they're not eating from the same menu. They're eating something else. They're eating lower trophic levels than everybody else at the site. They could be enemies who were killed and buried on a sacred -- in a sacred burial ground. Okay? They could be allies from somewhere else who came to fight a common enemy and then were buried without ceremony, in a sacred place, but kind of flung in the pit. I had somebody suggest to me they were the town vegans, and people just got fed up and shot them dead and threw them in the hole. I don't know who they are. And I'm really curious to find out. And I'd be interested in your suggestions as well, about who they might be.

Okay, so in conclusion, what's on the menu in Santa Clara 38. Mostly terrestrial foods, some freshwater fish, some bay shellfish. Compared to other Central California groups, they're eating less marine than people on the coast or right by the bay. Not a real shock. A little more freshwater fish and shellfish maybe than other south bay sites, and less fish than the Delta or the Central Valley. So positioned within the area, kind of what you'd expect. But still, it's good to know this so that when you have outliers you can see where they fit, as we just did. Within the group, diet's not correlated with age but is correlated with sex. Although that doesn't explain all of the variation. There's more going on there for sure. As far as burial regalia goes, the mortuary goods that we're finding. Beads are meaningful, especially A1a, Haliotis pendants – these pendants are approaching significance, so I would call them meaningful. Charmstones seem to be important too, very specific, and probably supporting this idea that shamans use charm stones. But burning and cremation associations with burial, projectile points, groundstone, bone whistles, bone awls or stone pipes – no pattern at all there. Interesting.

Finally, we looked at the outliers. They were breastfeeding babies. And we did confirm that we're seeing a 3 permil enrichment over mothers at least in the one case over the other adult male. Weaning foods are introduced at about one to one-and-a-half years. And cessation of breastfeeding by three to three-and-a-half years. Which is a little later than we expected. And the mystery men? They're still mysterious. I don't know who they are. But I'm looking to find out.

Further research questions from here. I'm looking to correlate more about the burial context to diet. There was a really wonderful master's thesis written about the mortuary associations at this site that found some significance to clustering within the site, and perhaps having to do with clans and that sort of thing. So I'd like to look into that, see if diet plays in there as well. Looking at the burial position, to see if it matters, if they're flexed, if they're tightly flexed, if they're buried in other unusual situations, extended or flung. Looking at moiety associations, that's the clan associations, again. There seem to be markers of bear or deer associations there. So seeing if I can find meaning there. I mention there's ancient DNA research going on, and I'm very excited to see what that tells me about relationships and what that then can tell me about dietary patterns. Finally, I've just begun exploring sulfur as another alternative, many thanks to Dr. Bartlink, who's also looking into this. Sulfur might be a good way to trace sources location, to trace people on the landscape and see where they're from in that way. So I'm already looking into the mystery men, seeing if I can tie them to place, somewhere other than Santa Clara 38. Sulfur isotopes have also been suggested as an interesting way to look at weaning foods, those foods that are first introduced.

Any questions? As I said, this is preliminary research, the thesis defense will be happening this fall. Stay tuned for further conclusions. And that's what I've got for you today. This wouldn't have been possible without all of these wonderful people. I'm very grateful for their help. Thank you very much.

[Applause]