LATE PLEISTOCENE AND HOLOCENE PALEOENVIRONMENTAL CONDITIONS IN THE LOWER SANTA YNEZ RIVER BASIN

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ABSTRACT

Holocene paleoenvironmental conditions in the lower Santa Ynez River drainage basin have been inferred from palynological and sedimentological data derived from two sediment cores. These cores extend the terrestrial palynological record for central California back to about 11,000 radiocarbon years B.P. Pollen data suggest a trend from cool, mesic conditions (pre-10,000 RCYBP) to warmer, mesic conditions in the early Holocene. The trend intensifies after 10,000 RCYBP, peaks between 6,700 and 4,200 RCYBP and returns to cooler conditions beginning about 4,000 RCYBP. This cooler, more mesic interval lasts until initiation of a short warm, dry period from 1,800 to 600 RCYBP. Cooler, more mesic conditions prevail during the last 600 RCYrs. Stratigraphic sequences suggest higher ground-water levels began about 4,000 RCYBP and are consistent with the palynological data.

INTRODUCTION

A major research question posed for the Union Project related to the paleoenvironmental conditions in the Santa Ynez River valley. Specifically this question was:

- How has the environment changed over the period of human occupation and how has this affected the presence, extent, and probable location of important resources?

During the Union Project, a considerable effort was made to address this question. This paper will focus on the palynological and sedimentological investigations conducted in support of this research. Although we collected data throughout

the river basin, our most intensive and successful sampling efforts occurred in Santa Lucia and Oak canyons (Figure 1).

PREVIOUS INVESTIGATIONS

Before presenting the data collected during the Union Project, we should review the major existing sources of paleoenvironmental data for the study area (Figure 2).

Sea-Surface Temperature Fluctuations

Pisias (1978, 1979) reconstructed an 8,000-year sea-surface temperature curve for the Santa Barbara basin based on radiolarian assemblages in varve sequences. The assemblages were used to infer changes in oceanic conditions as well as in atmospheric temperature and precipitation.

In general, environmental reconstruction based on these data suggest substantially elevated sea-surface temperatures prevailed during three intervals:

- 800 to 1800 B.P., sea-surface temperature 4 to 6 degrees Celsius warmer than present;
- 3400 to 3900 B.P., 5 to 8 degrees Celsius warmer than present; and
- 5400 to 8000 B.P., 2 to 8 degrees Celsius warmer than present.

Holocene Botanical Change in Coastal California

In 1978, Heusser published the only detailed palynological investigation for the project area based on pollen from a sediment core from the Santa Barbara basin. Her study provides a record of coastal vegetation for the past 12,000 years and has been extensively referenced in the archaeological literature.

Heusser's (1978) pollen record found temporal variation in the distribution of upland and lowland vegetation communities. General paleoenvironmental conditions were inferred from the pollen record.

The conclusions of Heusser and Pisias do not fit well together and this discrepancy has left some ambiguity in developing a reliable paleoenvironmental model for the Late Pleistocene and Holocene.

UNION PROJECT INVESTIGATIONS

Stratigraphic pollen columns were collected from two locations: Santa Lucia Canyon and Oak Canyon.

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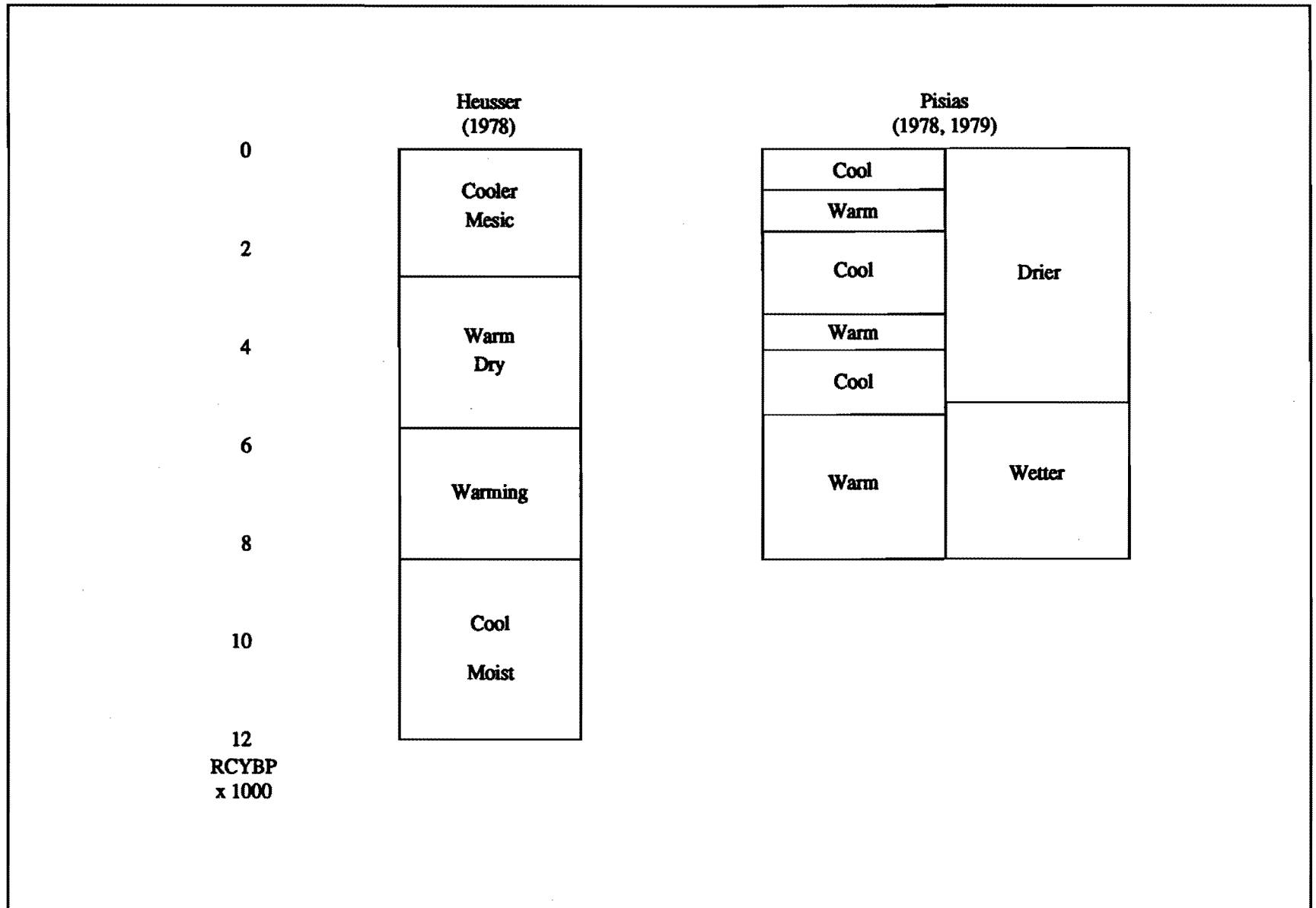

Figure 2. Paleoclimatic data for Santa Barbara Channel area.

Sample Collection Methods

The single core removed from near the spring in Santa Lucia Canyon was collected to a depth of 4.8 m using a truck-mounted hydraulic corer. Pollen samples from Oak Canyon were first collected along an exposed face of the pipeline trench, then from a nearby core excavated to a depth of 6.6 m to extend the pollen record below the bottom of the trench.

Sedimentological samples recovered by the coring operations were described in the field with respect to their texture, color, and major sedimentological features. In the laboratory, each of the samples was more thoroughly described. Further grain-size analysis was performed at certain intervals within each of stratigraphic unit.

Pollen samples were removed at estimated 10 cm intervals from both the trench and the cores. The hydraulic corer compressed some of the sediments, so the estimated 10 cm intervals took into account compaction of the soil during coring. The pollen grains were extracted from the sediment and identified under a light microscope. Portions of the cores that corresponded to sedimentological or pollen changes were selected for radiocarbon dating.

Santa Lucia Canyon Core

Santa Lucia Canyon is an 8 km valley with an intermittent stream that extends from the Purisima Hills to the Santa Ynez Valley. The pollen core was extracted from the canyon floor near a spring that originates 35 m above the canyon floor. This sampling location is about 4.5 km from the mouth of the canyon.

Current vegetation near the spring includes aquatic and marshy vegetation such as cattails, grasses, sedges, nettles, dock, mint, umbels, knotweed, thistles, willows, and eucalyptus. Several of the species around the spring are non-native. Archaeological sites SBa-1742, SBa-1743, SBa-1896, SBa-1991, SBa-1992, and SBa-1993 lie less than a kilometer from the spring.

Sedimentology

Deposits recovered from the coring activities in Santa Lucia Canyon can be divided into three major depositional sets (Figure 3): Depositional Set 10, Depositional Set 20, and Depositional Set 30. Depositional sets 20 and 30 include sediments deposited by surface water flowing through Santa Lucia Canyon. Depositional Set 10, the latest set, represents sediments from the nearby spring that formed as a result of a higher water table.

Depositional Set 30 is the lowest of the three depositional sets and is divided into four strata, numbered 31 through 34 from top to bottom. This depositional set extends from 410 cm

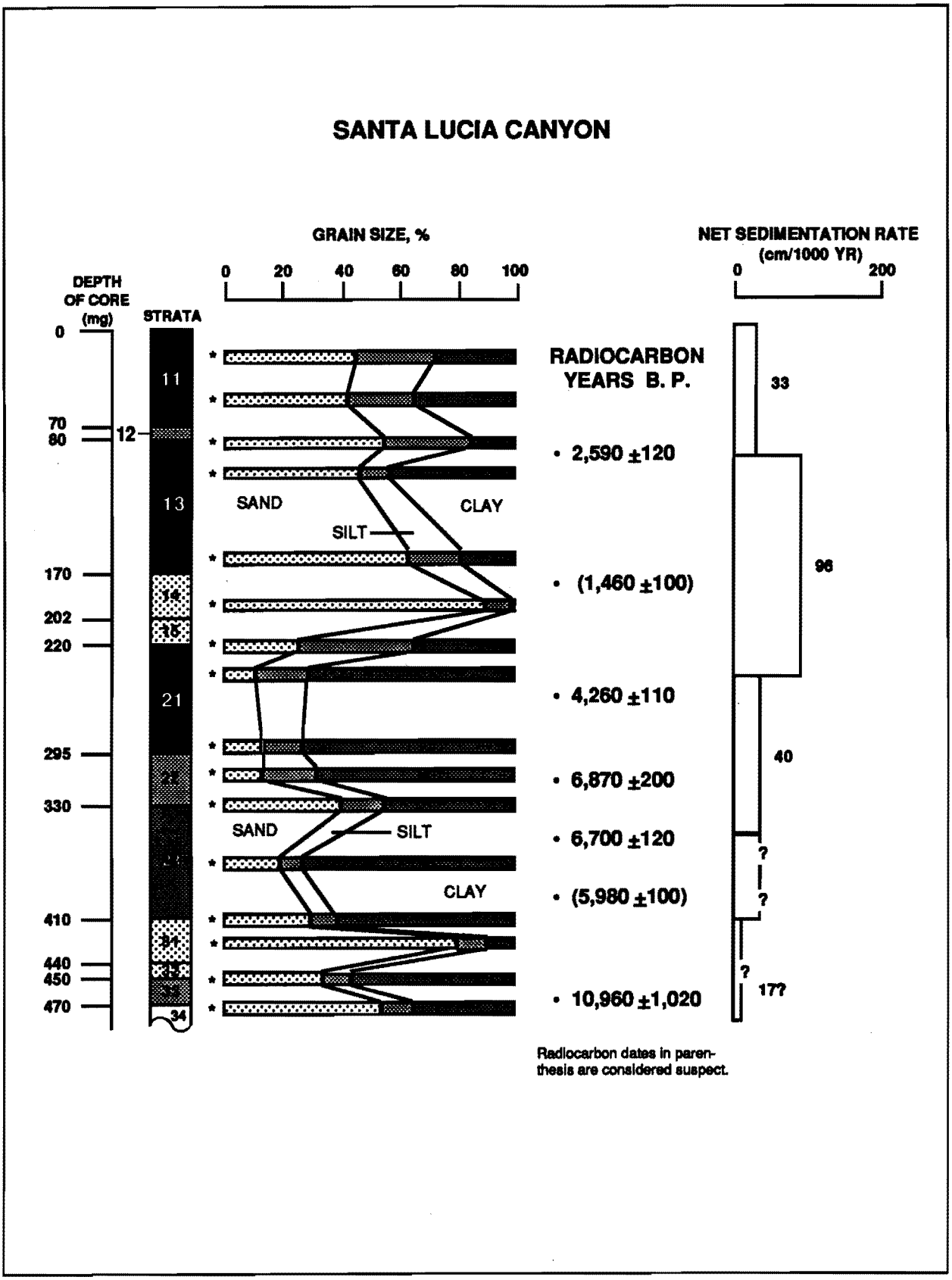

Figure 3. Stratigraphy of Santa Lucia Canyon core.

to 480 cm below the surface and has a sandy texture. Typically, most of the strata consist of more than 50 percent sand. Textures of individual strata range from loamy sand to clay to sandy clay loam. The gravel content is about 2 percent in stratum 34, decreases slightly to 1 percent in strata 33 and 32, and is 2 to 3 percent in stratum 31. In stratum 31, about 1 percent of the gravel is larger than 4 mm and some pieces are as large as 3 cm. Pale brown (10YR6/3) and brown (10YR4/3) colors dominate this depositional set.

Depositional Set 20 extends from about 220 cm to 410 cm below the surface and has been divided into three strata (strata 21, 22, and 23). The boundary between depositional sets 20 and 30 is wavy and abrupt. This depositional set is significantly more fine grained than those of either Depositional Set 10 or 30. Sand contents generally are less than 40 percent and clayey textures prevail throughout all strata. Stratum 22 is slightly sandier than the other two strata. Gravel content does not exceed 1 percent in any stratum. Black (10YR2/1), very dark grayish brown (10YR3/2), and very dark gray (10YR3/1) colors characterize strata in this set.

Depositional Set 10 extends from the surface to a depth of 220 cm and is divided into five strata. The boundary between sets 10 and 20 is very abrupt and is irregular to broken. Sand contents are typically greater than 40 percent. Overall, there is an increase in sand content with depth, with sandy loams, loamy sands, and sandy clay loams being dominant. The gravel content in Depositional Set 10 increases with depth also, but does not exceed 1 percent in any stratum. Bedding was observed only in stratum 15, the lowest stratum. The bedding is discontinuous, even, nonparallel, and approximately 1 mm thick. Strata 14 and 15 are dark grayish brown (10YR4/2), and strata 11, 12, and 13 are black (10YR2/1).

Chronology

Samples of the stratigraphic record from the Santa Lucia Canyon core (Figure 3) were selected for radiocarbon analysis based on sedimentological changes in the core and changes observed in the pollen record. The radiocarbon dates from this core indicate that the sediments may extend back to about 12,000 radiocarbon years before present. All ages given in the following discussion are uncalibrated radiocarbon years before present.

Palynology

The core from Santa Lucia Canyon contained pollen from the surface to the base of the core at a depth of 4.8 m. The overall suite of pollen (Figure 4) identified from this site is reasonably constant throughout the core, however the relative percentages of each species or taxa do vary. Select pollen

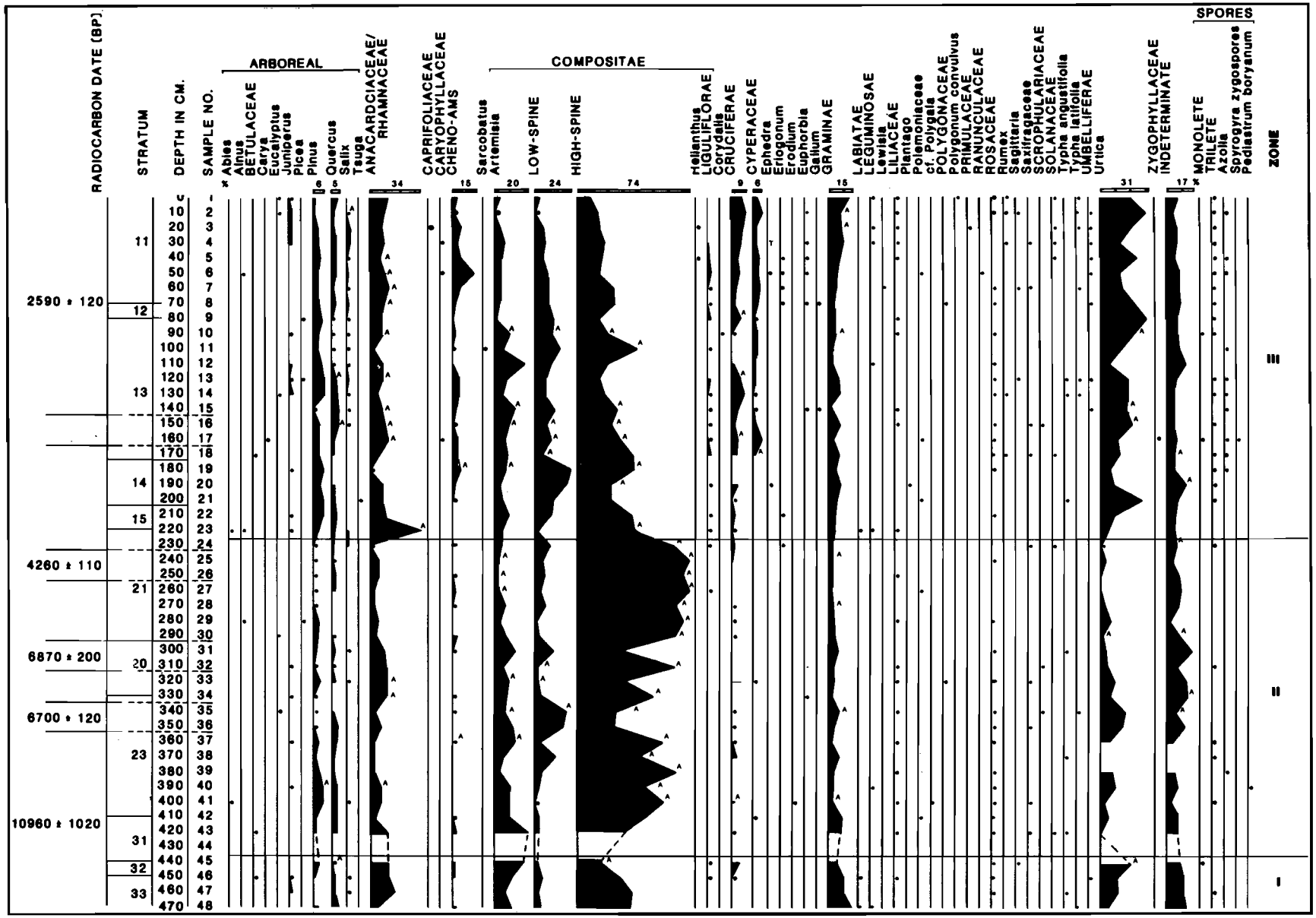

Figure 4. Pollen diagram for Santa Lucia Canyon core.

frequency columns are especially important to our interpretations:

- Compositae, in particular the high-spine;
- Sumac/buckthorn family (Anacardiaceae/Rhamnaceae);
- Nettles (Urtica);
- grasses (Graminae); and
- oak (Quercus).

Three pollen zones were identified in the Santa Lucia Canyon core. The central and lower portion of core, extending from 4.3 to 2.3 m below ground surface (strata 21 through 31), contain large quantities of Compositae pollen, primarily of high-spine composites (sunflower and Aster). High frequencies of Compositae pollen indicate open, warm habitats in which members of the heliotropic sunflower family thrive.

Upper zone extends to about 2.3 m below the surface (stratum 21) and is characterized by an abrupt decrease in Compositae pollen paralleled by a rise in nettles (Urtica) pollen and the introduction of a variety of fern spores. Nettles are an indicator of cool or moist conditions. Above a depth of 2.0 m (strata 11 through 14), the high frequencies of nettles pollen are accompanied by a slight increase in Graminae pollen and the introduction of sedge family (Cyperaceae) pollen. Cattail (Typha) pollen also occurs more regularly in these deposits. Water-fern spores and algae recovered in sediments from Santa Lucia Canyon, primarily from the upper 2.0 m of sediments, also indicate that moister conditions prevailed during the later period of deposition.

Oak Canyon Core

Oak Canyon is about 4.5 km long and is about 1.5 km west of Santa Lucia Canyon and also contains an intermittent drainage. The pollen core was taken at the mouth of the canyon about 300 m from the Santa Ynez River. Nearby archaeological sites include SBa-687 and SBa-914.

The modern vegetation in the bottom of Oak Canyon has been disturbed recently and is composed of umbels (Umbelliferae), thistles (Compositae), yellow-flowered composites (Compositae), grasses (Graminae), mint (Labiatae, cf. Marrubium), members of the potato/tomato family (Solanaceae), and legumes (Leguminosae). The hillsides support dense to scattered stands of oaks (Quercus), grasses (Graminae), composites (Compositae), wild buckwheat (Eriogonum), and poison oak (Toxicodendron).

Sedimentology

Sediments in the Oak Canyon core were divided into three depositional sets based (Figure 5) on texture, color, and consistency. These sediments are labeled depositional sets 10, 20, and 30, from top to bottom.

Depositional Set 30 extends from 445 cm to 635 cm beneath the surface and is divided into three strata, designated 31.1, 31.2, and 32 that have a general increasing sand content with depth. Gravel content is 1 percent or less in all strata.

Depositional Set 20 extends from 50 cm to 445 cm beneath the surface and is divided into eight strata. Textures in this depositional set are primarily clays, loamy clays, and sandy loams. Sand percentages generally increase with depth through stratum 25.2, but decrease dramatically in stratum 26. Gravel contents have a maximum of about 2 percent in stratum 24. Depositional Set 20 is generally black to very dark grayish brown.

Depositional Set 10 extends to a depth of 50 cm and is divided into 4 strata. Sand content increases with depth and all strata have gravel contents below 1 percent. Very dark grayish brown (10YR3/2) to dark brown (10YR3/3) colors are typical. In stratum 13, yellowish red mottles about 1 cm in maximum diameter are common.

The extensive backhoe trench across Oak Canyon allowed us to examine stratigraphy down to stratum 25.2. The overall stratigraphic sequence remained remarkably constant across the valley. No evidence was found of a main channel or series of channels through which the Oak Creek watershed would have drained. Therefore, we have concluded that Oak Canyon definitely has not had a defined stream channel for at least the last 2,000 to 3,000 years, the approximate age of stratum 25.2. It is even possible that Oak Canyon did not have a discrete stream channel during the last 4,000 years.

Chronology

The radiocarbon chronology for the Oak Canyon core was established by eight mean residence time (MRT) dates (Figure 5) on the bulk organic carbon in the sediments. Five of the dates are believed to be valid. All ages mentioned below represent uncalibrated radiocarbon years before present.

Palynology

The pollen record from Oak Canyon (Figure 6) exhibits changes in the local environment comparable to those inferred from the Santa Lucia Canyon core. The major changes include shifts in the frequencies of High-Spine Compositae (e.g., Aster), rose/buckthorn family (Anacardiaceae/Rhamnaceae), and mustard family (Cruciferae) pollen. Less pronounced changes

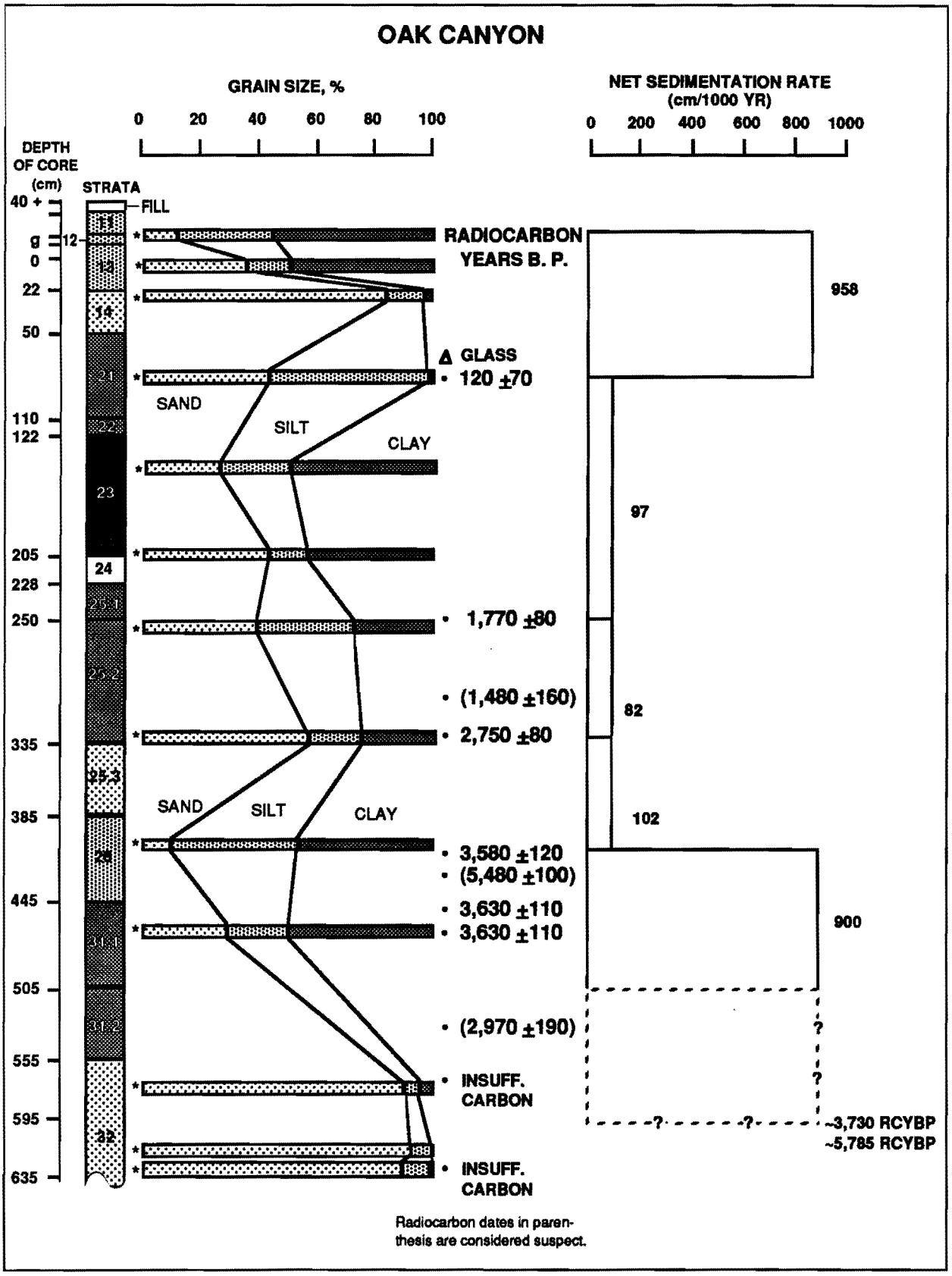

Figure 5. Stratigraphy of Oak Canyon core and trench face.

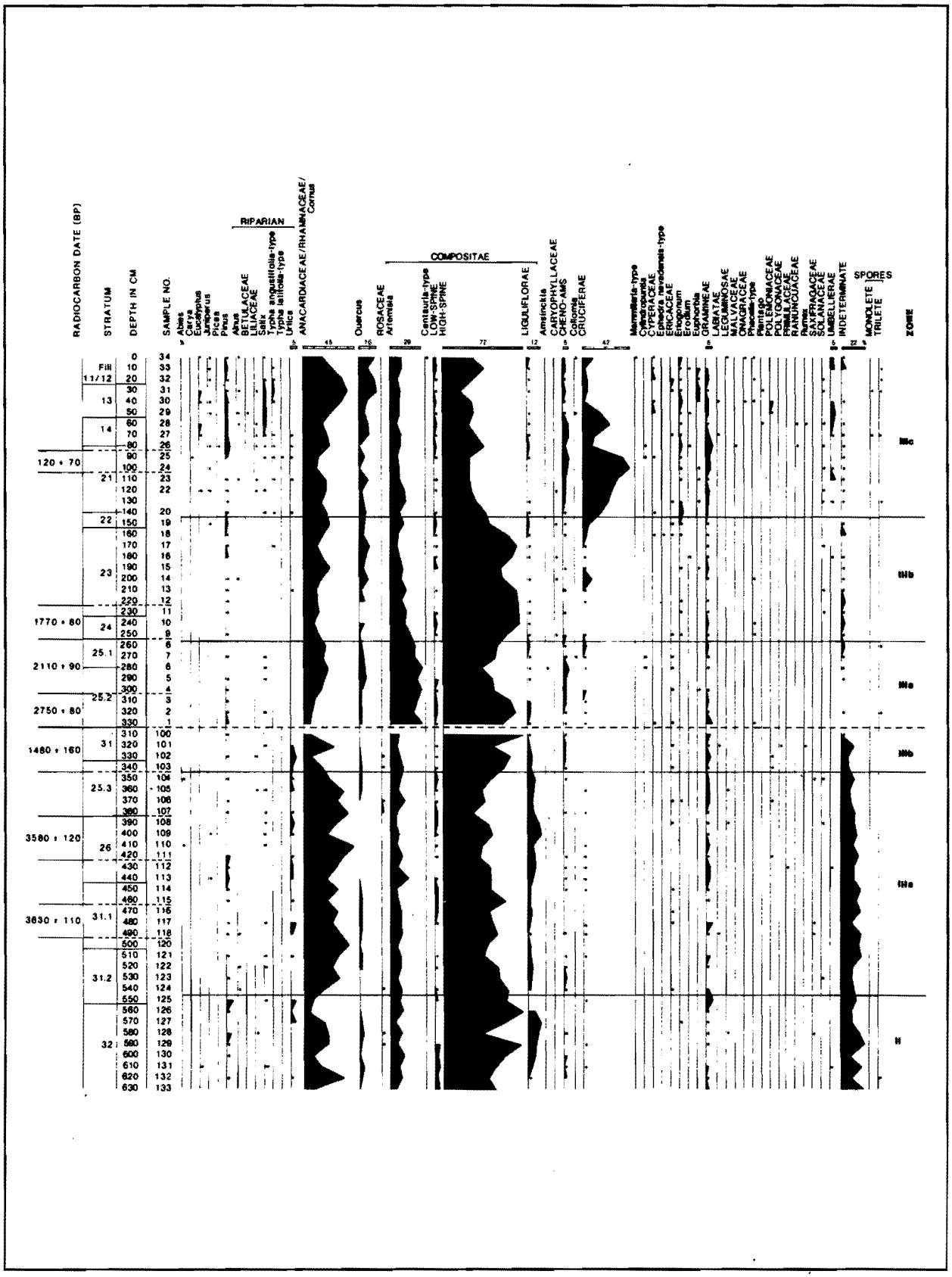

Figure 6. Pollen diagram for Oak Canyon core and trench face.

were observed in oak (Quercus), grasses (Graminae), and nettle (Urtica) frequencies.

The lowest portion of core contains relatively high frequencies of High-Spine Compositae pollen and relatively low but fluctuating frequencies of sumac/buckthorn family (Anacardiaceae/Rhamnaceae) pollen. An increase in sumac/buckthorn family pollen is observed at a depth of about 540 cm. High-spine Compositae increase at about 250 cm accompanied by generally decreasing sagebrush (Artemisia). Sharp decreases in Compositae pollen and increases in mustard pollen occur at 150 cm depth. In the highest levels of the record, there were increases in Cruciferae and Graminae pollen, which suggest that mustard and grasses replaced some of the composites on the canyon floor.

SYNTHESIS

When the paleoclimatic interpretations derived from the sedimentological and palynological data are placed in their approximate time frames (Figure 7), it is evident that the Santa Lucia And Oak Canyon records are compatible.

Overall, we interpret the following late Pleistocene and Holocene paleoenvironmental conditions:

- cool, mesic conditions pre-10,000 RCYBP;

Higher gravel and sand content sediments from Santa Lucia Canyon suggests that surface-water flow rates may have been higher during the late Pleistocene than today. The pollen suite indicates elevated nettle, grass, and sumac/buckthorn family frequencies (Anacardiaceae/ Rhamnaceae).

- warming and drying sequences from 10,000 to 4,000 RCYBP;

Large frequencies of High-Spine Compositae pollen at Santa Lucia Canyon, are accompanied by a decrease in chaparral components and nettle (Urtica) pollen. Sedimentological data from the Santa Lucia Canyon core show increases in the fine-grained component of the sediments in Depositional Set 20. These sediments suggest a time of quiet water and little water flow, which one would expect with warmer and drier conditions. Radiocarbon dates and the pollen record indicate the more intense warm, dry conditions occurred between 6800 and 4200 B.P.

- cool, mesic conditions from 4,000 to 1,800 RCYBP;

Late Holocene stratigraphy from Oak Canyon supports the contention of higher ground-water levels as inferred by the initiation of a spring in Santa Lucia Canyon. Higher organic matter content in Depositional Set 20 in Oak Canyon and the absence of a stream channel both suggest that, during the last

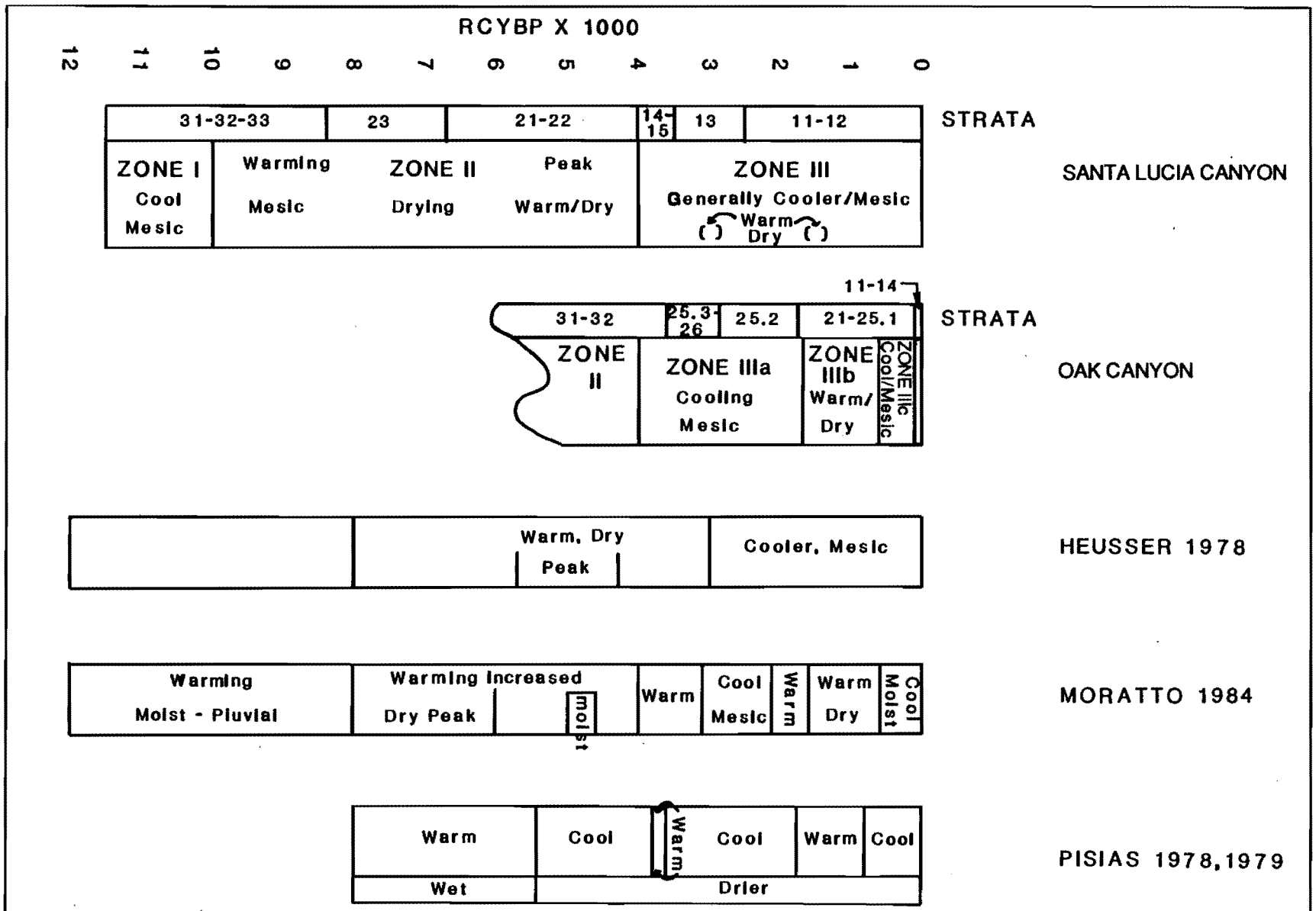

Figure 7. Paleoenvironmental summary.

4,000 years, water was shallow and velocities were low. Standing water may have occurred periodically on the Santa Lucia Canyon floor.

The Oak Canyon pollen record does not contain evidence of either a spring or a permanent drainage and is marked by a slight decline High-Spine Compositae pollen and an increase in chaparral pollen (Anacardiaceae/Rhamnaceae) and tree pollen (Juniperus, Pinus, and Quercus).

- o warm, dry conditions from 1,800 to 600 RCYBP;

Large quantities of High-Spine Compositae pollen are accompanied by relatively low frequencies in chaparral pollen types. Mustard (Cruciferae) and grass (Graminae) pollen are common.

- o cool, mesic conditions from 600 RCYBP to present.

This time period is marked by a decrease in High-Spine Compositae pollen and increases in chaparral, sagebrush (Artemisia), grasses (Graminae), nettles (Urtica), and mustard (Cruciferae) pollen. These changes represent a return to cooler or more mesic conditions.

These data are also compatible, in a general sense, with Heusser's data (Figure 8). However, substantial differences exist when compared to other researcher's data. In general, variations in the pollen record at Oak Canyon and Santa Lucia Canyon represent changes in the local distribution of the coastal sage scrub and the chaparral communities. For example, increases in oak (Quercus), sumac/buckthorn (Anacardiaceae/Rhamnaceae), and rose (Rosaceae) pollen indicate an expansion of the chaparral community, probably at the expense of the coastal sage scrub communities.

High frequencies of various Compositae pollen types indicate that the coastal sage scrub community was more extensive than chaparral. Palynologists have often found that composites are associated with warmer intervals (Heusser 1978). Increases in Urtica (nettle) pollen and fern spores are assumed to represent cooler, moister conditions typical of riparian habitats.

SUMMARY

Union Project palynological and sedimentological data show a good correlation between the Santa Lucia and Oak Canyon stratigraphic records and the general trends of Heusser (1978). Geomorphic and palynological evidence suggest that the climatic conditions during the last 4,000 years were more mesic than before and that ground-water levels were somewhat higher than during the middle Holocene. The appearance of a spring near the site of the pollen core in Santa Lucia Canyon may be due to the

more mesic conditions of the late Holocene. Mesic conditions may have resulted from a change in the type of precipitation in the region or a major change in the amount of annual precipitation. Both geomorphic and palynological data support a pattern of high-frequency, low-magnitude precipitation events.

As will be seen, the major trends observed by Heusser (1978) are generally consistent with data from the Union Project (Figure 8). However, there are discrepancies between the timing of the climatic changes. This temporal variability may be the result of the genesis of the sediment from which the pollen was extracted. Heusser extracted pollen from marine sediments to develop a paleoenvironmental reconstruction. Terrestrial data sets used in the Union Project indicate that climatic changes occurred about 1,800 to 2,000 RCYrs before Heusser's marine data. This lag time may represent the time required to transport the eroded sediments and associated pollen into a marine setting.

Many archaeological investigations have relied heavily on Heusser's data. Data from this project suggest that climatic changes have not been dramatic during the Holocene as evidenced by the lack of major changes in the pollen record. It is interesting to note that oak has been present in the study area since the late Pleistocene, but was not prevalent in the pollen record at any time.

One last observation is possibly worthy of note; it is interesting to note the temporal relationships, or lack thereof, between the boundaries of the most prominent climatic changes and the current prehistoric chronology for the region. Based on our current state of knowledge, there does not seem to be a simple correlation between the Holocene climatic shifts and cultural periods. Cultural change is rarely so easily explained. Nonetheless, it is clear that by documenting paleoenvironmental conditions we can identify and isolate factors which did influence cultural change along the central California coast. We are hopeful that future investigations of this nature will help explain the degree to which paleoenvironmental conditions influenced the settlement and subsistence patterns of prehistoric groups along the central California coast.

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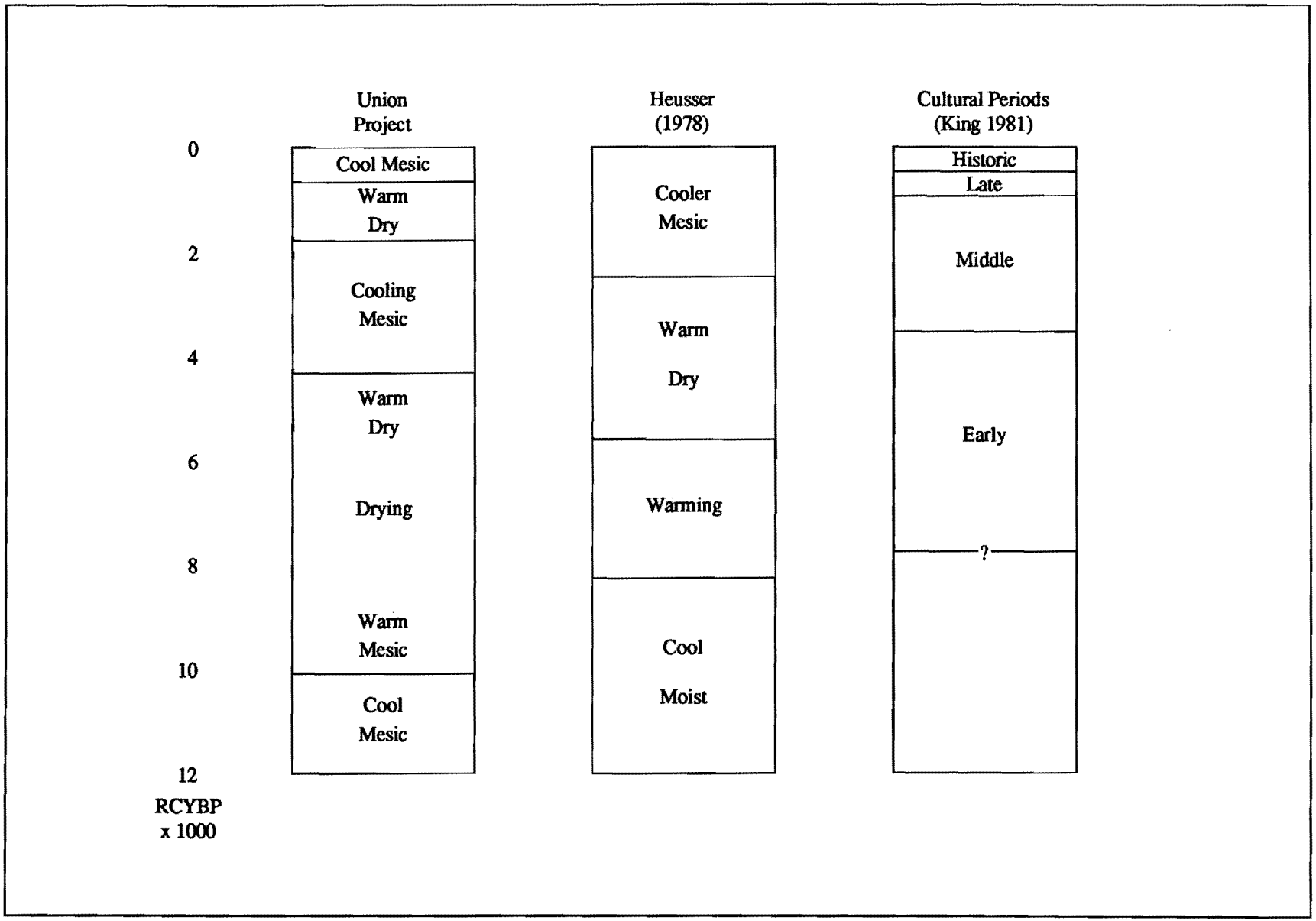

Figure 8. Comparison of cultural periods and paleoclimates.

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