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Historic and Holocene environmental change in the San Antonio Creek Basin, mid-coastal California

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ABSTRACT

Using a combination of pollen, non-pollen palynomorphs (NPPs) and charcoal particle stratigraphies from sediment cores from two sites, along with historical records, we reconstructed paleoenvironmental change in mid-coastal California. The San Antonio Creek section contains a discontinuous, Holocene-length record, while Mod Pond includes a continuous late Holocene record. Together the records allow for interpretation of most of the present interglacial. The longer record documents coastal sage scrub and chaparral dominated by woodland elements early in the Holocene to about 9000 yr ago, a potential decline in woodland communities with drying conditions during the middle Holocene to about 4800 yr ago, and an expansion of coastal sage scrub with grassland during the late Holocene. Evidence for climatic fluctuations during the last 1000 yr at Mod Pond is equivocal, suggesting that the Medieval Climate Anomaly–Little Ice Age had modest impact on the Mod Pond environment. However, evidence of significant environmental change associated with cultural transitions in the 18th–19th centuries is stark. Introduction of non-native plants, establishment of cattle and sheep grazing, missionization of the native population, changes in burning practices during the Spanish period and enhanced cropping activities during North American settlement worked together to substantially modify the mid-California coastal landscape in about a century's time.

Introduction

The Holocene history of vegetation change in southern California is incompletely known due to various factors. In this dry Mediterranean climate few lake basins hold water throughout the year enabling continuous accumulation of organic sediment over long periods of time, and few of those have been analyzed for pollen (e.g., Mensing, 1998). In addition, the pace of human development in southern California accelerated during the 20th century, modifying or covering many former inland and coastal marshes that could have preserved long paleoecological records (Mattoni and Longcore, 1997; Grossinger et al., 2007; Dark et al., 2011). Significant groundwater withdrawal has potentially effected wetland preservation by lowering water tables which eventually dry out small ponds, wetlands and marshes, resulting in loss of organic deposits either through decomposition or aeolian action. These factors have contributed to limited opportunities to determine the characteristics of former environments in this region. In spite of these limitations, records from vernal pools (Anderson et al., 2010), remnant coastal marshes (Davis, 1992; Cole and Liu, 1994; Cole and Wahl, 2000), alluvial sections (Anderson and Byrd, 1998) or off-shore basins (Heusser, 1978, 1995, 1998; Mensing, 1998) have yielded important paleoecological information.

Given the limitations, military reservations along coastal California have played an important role in preserving critical habitat by limiting widespread development, thus preserving key paleoecological (e.g., Anderson and Byrd, 1998) and archeological (Glassow, 2002) sites. The history of Vandenberg Air Force Base (VAFB) is a case in point. After occupation by Native Americans throughout the Holocene, European settlement in the Vandenberg area began in 1787 with the establishment of Mission La Purísima. Farming and ranching were the primary economic activities during the Spanish period (Lebow et al., 2013). By 1820 and independence from Spain, much of the area was divided into ranchos. Ranching remained a principal activity throughout the 19th and early 20th centuries until the beginning of World War II,

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when, in 1941, 86,000 acres of coastal ranch and farm land was condemned to form Camp Cooke. In 1958 Camp Cooke was converted to Vandenberg AFB.

Here we use pollen, NPPs (non-pollen palynomorphs) and sedimentary records of two sites to determine former environments of the San Antonio Creek drainage on VAFB, a region preserving one of the largest contiguous sections of coastal sage scrub and chaparral in mid-coastal California. One site – an alluvial section along San Antonio Creek – contains a discontinuous but Holocene-length record, while the second site – Mod Pond – includes a continuous late Holocene record of coastal sage scrub. Analysis of the two records together allows for interpretation of most of the present interglacial. Our ca. 2800-yr paleoecological record from Mod Pond includes the first late Holocene high-resolution fire history for the region, evidence of the Medieval Climate Anomaly (MCA), and details of the transition into the Spanish colonial period and its impact on the landscape.

Site setting

Mod Pond and the San Antonio Creek (SAC) sections are on VAFB in mid-coastal California (Fig. 1). Mod Pond is a small, perennial pond at 21 m asl, ~3.5 km SE from the Pacific Ocean (Fig. 2), at N 34°47′15″, W 120°35′11.3″. The pond – roughly kidney bean shaped, ~400 m long by 120 m wide – occurs in a NE-SW trending basin immediately south of a sequence of dunes on San Antonio Terrace, an uplifted marine terrace immediately north of the San Antonio Creek Valley. It has a small internal drainage, perhaps 4–5 times the size of the pond itself.

The SAC section (N 34°46′35.5″, W 120°29′39.8″) occurs in alluvium along San Antonio Creek, which begins in the San Rafael Mountains, flowing ~45 km to the Pacific Ocean, draining 400 km^2 (California Polytechnic State University, 1995). The section occurs at ~61 m elevation as part of a 6 km reach of deeply incised streambed west of Barka Slough, northwest of Purisima Hills (Fig. 1).

Geology

Franciscan Assemblage rocks form the basic unit of the study area (Jurassic; Dibblee, 1950, 1988). This includes graywacke, shale mixed with chert, metavolcanic and metaplutonic rocks, ultramafic rocks, limestone, and conglomerate (Dibblee, 1988). Here San Antonio Creek valley occurs between two anticlines – the Casmalia (north) and Purisima (south) Hills. The San Antonio Terrace, including Mod Pond, is underlain by Miocene Sisquoc and Monterey Formations, and overlain by Pleistocene Orcutt Sand (Lebow et al., 2013).

Modern climate

The climate of the region is maritime Mediterranean, with moist winters and warm, dry summers, but with mild temperatures and little fluctuation during the year. Long-term climate data for Santa Barbara (66 yr), 1 m asl, show typical annual patterns for coastal southwest California (Anderson et al., 2010). Average monthly temperature varies from 18.4°C in January to 25.2°C in August (WRCC, n/d, accessed April, 2008). Average monthly precipitation varies from 103.9 mm in February to near zero during the months of June–September.

The climate is also influenced by dynamics of the California Current and the California Counter (Davidson) Current (Moody, 2000; Herbert et al., 2001). The California Current brings colder water southward parallel to the coast, whereas the California Counter Current carries warmer water northward. The relative influence of these two currents has been an important influence on the climate and vegetation along the coast throughout the late Quaternary (Herbert et al., 2001).

Modern vegetation

Mod Pond and the SAC section occur within the coastal sage scrub vegetation type, an association covering between 10,110 ha (25,000 ac) and 12,950 ha (32,000 ac) on VAFB (Coulombe and Cooper, 1976), but also widely distributed along south coastal California (Mooney, 1988). Coastal sage scrub is a diverse community dominated

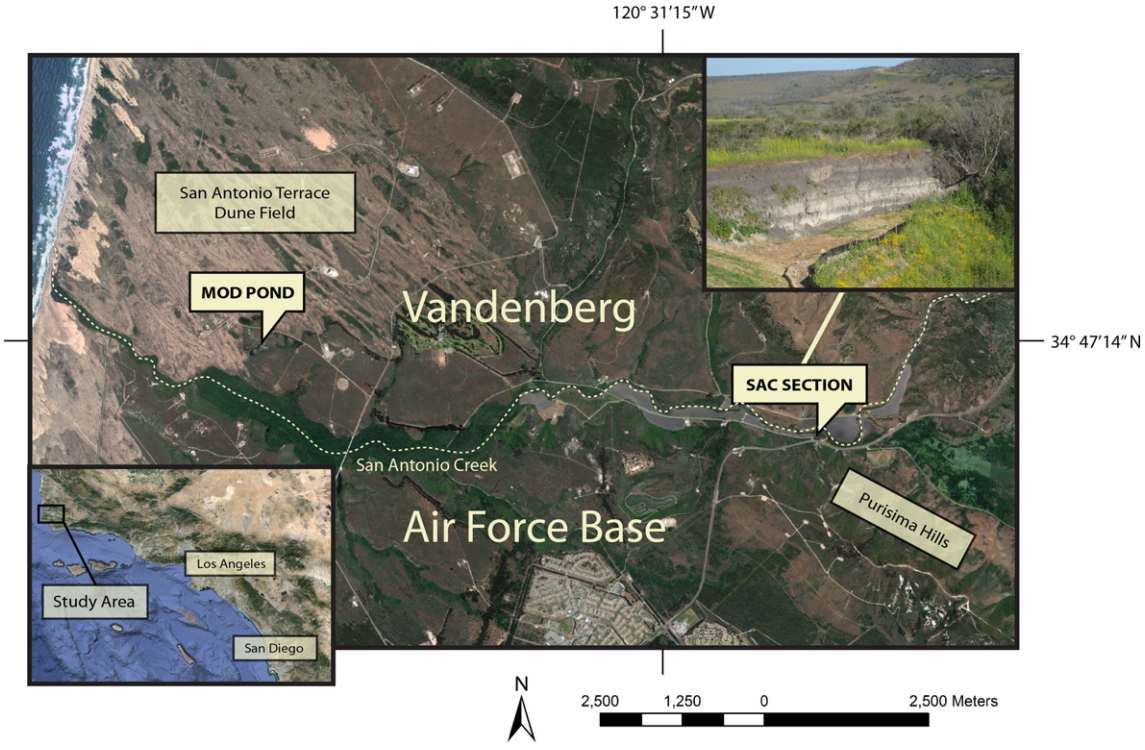

Figure 1. General location of Mod Pond and San Antonio Creek (SAC) section on Vandenberg AFB, California, with an inset of the exposure along San Antonio Creek, which includes all core sections and their associated radiocarbon dates mentioned in the text.