Introduction: Tectonics, volcanism, and stratigraphy within the evolving transform margin north of San Francisco Bay, California

V.E. Langenheim1 and D.S. Sweetkind2

1U.S. Geological Survey, 345 Middlefield Road, Mail Stop 937, Menlo Park, California 94025, USA
2U.S. Geological Survey, Denver Federal Center, Mail Stop 973, Denver, Colorado 80225, USA

The geology and tectonic history of the northern San Francisco Bay (North Bay) region, California, has not previously been studied in great detail despite the proximity of major population centers to the San Andreas Fault system. Here, the transition from subduction to transform margin tectonics east of the San Andreas Fault took place during the late Neogene and was characterized by northward-younging volcanism and northward-propagating faults. This history is recorded by a complex assemblage of sedimentary and volcanic deposits that are cut and offset by an array of active strike-slip faults, which are the northward continuation of the eastern part of the San Andreas Fault system (East Bay fault system). The East Bay fault system has accommodated up to 175 km of right-lateral strike-slip, which in the North Bay is partitioned onto a broad array of strike-slip faults east of the San Andreas Fault. The kinematic history of this fault system and the timing and nature of coeval sedimentation and volcanism have significant implications for groundwater hydrology, seismic hazard, and the overall tectonic evolution of the Pacific-North American plate margin.

Detailed geologic mapping, 40Ar/39Ar dating, and tephrochronology within the Rodgers Creek-Maacama fault system (McLaughlin and others) provide new stratigraphic correlations that define the slip rate and kinematics of this fault system and its long-term contribution to the slip budget of the transform margin north of San Francisco Bay. New geophysical studies (Langenheim and others) provide an important cornerstone for interpreting basin evolution and the fault zones in the North Bay area. Gravity data are used to estimate the thickness of sedimentary and volcanic deposits and infer the three-dimensional geometry of fault-controlled basins. Aeromagnetic anomalies reflect magnetic Mesozoic basement rocks (ophiolitic rocks including serpentinite, gabbro and basalt) and magnetic rocks within the various Tertiary volcanic rocks both exposed and in the subsurface. Magnetic data are used to refine fault locations, suggest correlations across faults, and identify buried volcanic centers. Analysis of gravity and magnetic data bears on fault linkages, the mechanism of basin formation, and the overall tectonic evolution of the region.

The North Bay region is also a type locality for slab-window volcanism, where northward-younging volcanic fields are inferred to track the trailing edge of the subducting slab as the Mendocino Triple Junction migrated north. Neogene volcanic rocks in the North Bay thus provide a “window” into the asthenosphere during this transition from subduction to transform margin tectonics. They can also provide key markers for reconstructing right-lateral displacement along the North Bay fault system, but previous investigations of North Bay volcanic fields have been hampered by stratigraphic complexity, lack of lithologic continuity of many of the units, and lack of age control. Several papers in this volume provide important new constraints on the volcanic architecture of the various volcanic fields—in particular the long-lived, voluminous Sonoma Volcanics—and their geochemical and geophysical signatures.

Over the past several years, the California Geological Survey has produced a series of 1:24,000-scale geologic maps of the North Bay area; in many places these represent the first new geologic mapping since the 1970’s. This mapping, supported by radiometric dating and tephrochronologic correlations, provides new insights into the volcanic, sedimentary and tectonic evolution of the northern San Francisco Bay area (Wagner and others). Volcanic centers on the east side of Napa Valley are particularly amenable to study since they lie east of the principal strike-slip faults and thus are less deformed than rocks to the west. Here, geologic mapping and petrography have been combined with geochemical data to define volcanic rock types, infer their eruptive style, and locate eruptive centers.

Geochemical data and limited new 40Ar/39Ar dates are used to correlate volcanic rocks and to define chemical trends of specific eruptive centers (Sweetkind, Ryutta, and others). Tephrochronology is a critical aspect of stratigraphic correlations in this region (Sarna-Wojcicki and others) and has enabled detailed geologic analysis of the Sonoma Volcanics.

The rapidly growing North Bay region is in part dependent on ground-water extracted from local sedimentary basins, and effective use of this resource requires a detailed understanding of the geologic framework of the shallow subsurface. Detailed three-dimensional analysis of lithologic and stratigraphic data from numerous water wells and other data from the Santa Rosa Plain (Sweetkind, Taylor, and others) has allowed a reassessment of the hydrogeologic system, including the thickness, extent, and three-dimensional distribution of each of the important aquifers.

The papers within this themed issue of Geosphere comprise a series of articles devoted to North Bay tectonics, stratigraphy, and volcanism. They are an outgrowth of concurrent studies in two five-year U.S. Geological Survey projects and a California Geological Survey mapping effort. Scientists from these three projects highlighted the preliminary results of their cooperative work in a technical session and associated field trip guide at the 2005 Geological Society of America Cordilleran Meeting in San Jose, California (Stevens and Cooper, 2005). This themed issue of Geosphere is an expansion and formalization of the ideas and discussions presented at the 2005 meeting. The papers demonstrate both the multidisciplinary approach and the breadth of geoscience information that is required to understand the tectonic history of the northern San Francisco Bay region. Because of their diversity, these papers will appeal to a wide range of earth scientists interested in these topics and approaches in the North Bay region and in application to analogous areas in other parts of the world.
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