tion is an unusual rapakivi-textured quartz-latite porphyry. A tertiary volcanic field, located about 169 mi (240 km) southeast of the Mint Canyon Formation in the northern Chocolate Mountains east of the San Andreas fault, contains the same variety of volcanic rock types as those that occur as clasts in the Mint Canyon Formation, including the unusual rapakivi-textured porphyry. Chemical analysis and isotope ratios of volcanic clasts from the Mint Canyon Formation and rocks from the volcanic field show them to be strikingly similar.

These data indicate that the Mint Canyon Formation is offset from the volcanic source by about 169 mi (240 km) of right slip along the San Andreas fault.

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Correlations Between the Onshore and Offshore Santa Maria Basins — A Dilemma

In an unexplored basin, extrapolation from known hydrocarbon-producing trends is ideal. However, along transform margins such extrapolations are difficult, owing to lateral displacement between individual blocks on both regional and local scales. An example of this is the relationship between the onshore and offshore Santa Maria basins, which are separated by the Hosgri fault.

Stratigraphic packages have been used widely to approximate amounts of displacement. Lower Miocene volcanics in the offshore Santa Maria P-060-Oceano well may correlate with onshore outcrops, located across the Hosgri fault, 30 mi (48 km) to the east and 45 mi (72 km) to the south, near Point Arguello. Additionally, lower Miocene volcanics also are present in two exploratory wells across the Hosgri fault, 10 mi (16 km) to the east and 25 mi (40 km) to the north, near Point Buchon. These are the Honolulu-Tidewater U. S. L. Heller Lease 1, with 4,722 ft (1,440 m) thickness of volcanics, and the Tidewater Motadoro 1, with 3,873 ft (1,180 m) of lower Miocene volcanics. These wells provide two volcanic sections onshore to tie with the offshore volcanics.

Originally, the lower Miocene volcanics now situated in the northern and southern extremities of the Santa Maria area, may have been joined near the midpoint of their present positions. As the onshore basin pulled apart, the volcanics were divided and transported in opposite directions. Synchronous pull-apart movements occurring in the offshore kept pace with the adjacent onshore. Alternatively, significant intrusive pathways may have opened in the later stage of basin development, allowing igneous material to migrate vertically. These pathways have been termed "leaky" transforms in the literature. Neither of these models necessitates significant lateral displacement once the onshore and offshore basins formed.

Onshore the middle Miocene Monterey Formation and upper Miocene to Pliocene Sisquoc Formation correlate well with equivalent chronostratigraphic units in the offshore P-060-Oceano well, implying that relatively minor lateral displacement has occurred since the middle Miocene. If the offshore basin history is similar to that of the onshore its petroleum potential may approximate that of the onshore, which has been projected to produce 900 million bbl of oil.

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Significance of Neogene Phosphorites in Capistrano Embayment, Southern California

The post-Relizian Monterey, Capistrano, and Niguel Formations comprise about 3,280 ft (1,000 m) of phosphorite-bearing marine sediments. Primary deposition appears to have been as pelletal and nodular phosphorite forming phosphoritic shales with occasional high-grade zones ranging up to 20 to 40% P_2O_5 and individual beds ranging up to 7 ft (2 m) or more in thickness. Most high-grade shale beds, however, are less than 3 ft (1 m) thick and average 20 to 25% P_2O_5. Some of the best exposures are in Aliso and Oso Canyons within the San Juan Capistrano quadrangle. Excavations for construction have exhumed weathered phosphorites at and below the water table exposing remobilized phosphate which is readily recognizable as vivianite [$Fe_3(PO_4)_2).8H_20$]. The purple (azurite colored) vivianite oxidizes on drying to a brownish color within a few weeks, thus it is rarely identified during conventional field mapping.

Large-scale landsliding within the Monterey and Capistrano Formations has commonly fractured phosphorite-bearing beds and allowed mobilization and redeposition of the original phosphorite as vivianite above the basal shear plane of block-glide landslides and downstream. Water in downstream drainages has the potential for being misidentified as a pollutant from septic systems. This suggests that geochemical techniques might provide valuable methods of exploration for certain phosphate occurrences.

Of several phosphorite basal conglomerates within or between the Monterey, Capistrano, and Niguel Formations, the best exposed and one of the best developed lies along the angular unconformity between the Monterey Formation and the overlying Niguel Formation on the east flank of the San Joaquin Hills, immediately north of the U.S. Geological Survey office at Laguna Niguel. This resistant phosphorite bed is composed of what appears to be nodules derived from the underlying Monterey Formation. They have been redeposited in and just below the littoral zone. Some of the phosphorite is concentrated in downslope channels within the neritic zone.

Additional exploration within the Capistrano embayment would probably yield economic amounts of phosphate rock. Rapid urban expansion in this part of southern California will probably preclude further exploration and development. However, as the Neogene phosphorite-bearing formations of the Pacific slope become better known, there may be substantial incentive for exploration and development in other areas. California is one of the largest consumers of phosphate in the United States and imports almost 100% of its supply from Florida, Idaho, and other areas. Potentially, millions of dollars could be saved annually in transportation costs and a strategic commodity (petroleum) would be conserved, if local deposits could supply the California market.

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Biostratigraphy and Paleoecology of a New Ostracode Fauna from Rincon Formation (Oligocene-Miocene), Los Sauces Creek, California

An ostracode fauna consisting of 10 new species occurs in the uppermost Zemorrian and lowermost Saucesian sections of the lower Rincon Formation, Los Sauces Creek, Ventura County, California. *Paracosta* and *Buntonia* dominate the assemblage, which is also represented by *"Paijenborchella," Loxoconcha, Acanthocythereis, Asymmetricythere, Cytherura, Xestoleberis,* and a new genus.

A predominance of complete carapaces infilled with pyrite and calcite indicates rapid burial in a slightly basic and reducing environment. The associated foraminiferal assemblages are mixed and include shelf-edge and lower bathyal (> 6,500 ft or > 2,000 m) markers. Several foraminiferal species in this fauna are characteristic of low-oxygen conditions. An oxygen-minimum zone may also have been the source of pelletal phosphorite in these thin-bedded mudstones. The overall lithologic and paleontologic evidence suggests deposition of these rocks as distal-fringe turbidites immediately following rapid basin subsidence.

Recognition of the ostracode peak zone in uppermost Zemorrian strata 43 mi (70 km) to the west, at Arroyo Hondo, demonstrates its biostratigraphic continuity in this region.

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Offset Panel Aids Processor and Interpreter

A novel display of common-offset profiles is found to be a powerful analytical tool for seismic data. The offset panel displays six sets of common-offset, single-channel data taken from a conventional marine seismic survey. The single-channel profiles are displayed below one another and arranged vertically by offset and horizontally by common depth point. This arrangement causes effects due to near-surface geologic changes to generate geometric patterns that are different from patterns due to changes in seismic source or receiver. Both reflection and refraction data are used in the display. Reflection data of the near trace or offset are at the top of the display and indicate the presence of acoustic boundaries. Refractions observed on distant traces are sensitive to changes in the near surface. They allow properties of acoustic layers to be determined through their alteration of transit times and amplitudes.

This display takes advantage of the exchangeability of seismic source and receiver to relate variations in refraction arrival time and amplitude at different offsets. Data commonly muted by the processor allow the detection of near-surface velocity anomalies from the simple geometric patterns they generate. The geometric patterns are symmetrical around the anomaly. A variation in refraction arrival due to change in source or receiver lacks symmetry and may be distinguished from a velocity anomaly.

Refraction arrivals penetrate to a depth of perhaps one-fifth the source to receiver distance, dependent on velocity distribution. A velocity anomaly anywhere in the path can be identified if one can compare refraction arrivals with and without the anomaly in the path. The offset panel arranges the data so that a comparison can be made.

The simple symmetry of the data in such a display renders it useful in many areas of analysis. For the data processor, the most important functions of the offset panel are to (1) verify field recording geometry, (2) monitor the seismic source, and (3) determine processing parameters. For the interpreter, the display serves to: (1) detect anomalous velocity zones in the near surface and allow for their correlation with deep structure, (2) locate and identify shallow, high-amplitude reflections, and (3) indicate shallow geologic changes.

Geotechnical and drilling engineers can use the display to: (1) locate zones of unstable sediments on the seafloor, and (2) locate and evaluate shallow drilling hazards.

Refraction data recorded by the conventional seismic spread are found to be very important in resolving problems associated with the near surface. They are most useful in the direct detection of shallow drilling hazards.

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Tectonic and Climate Controls on Sedimentation of Upper Miocene Nonmarine Strata East of San Francisco Bay, California

Upper Miocene nonmarine and shallow-marine strata exposed east of San Francisco Bay record a change from convergent-margin to transform-margin tectonics. During the late Miocene, the East Bay area occupied the oceanward side of a shelved fore-arc basin which was progressively incorporated in the evolving San Andreas strike-slip orogene. Patterns of deposition in the broad fore-arc basin were relatively simple: andesitic arc-derived detritus was transported the full width of the fore-arc basin from the Sierras to the East Bay area. In contrast, the wrench-tectonic regime produced complex patterns of sedimentation displaying greater local variability. Based on stratigraphic data from D. Wagner and our observations, we infer that the west-facing slope of the fore-arc basin in the East Bay area was reversed about 13 m.y. ago, with uplift of the area between the eventual traces of the San Andreas and Hayward faults. A fluvial clastic wedge was shed eastward into the East Bay area from this uplifted terrane of Mesozoic subduction-complex and fore-arc basin rocks. Initial rupturing along a "proto-Hayward fault zone" followed the uplift about 10 m.y. ago. Loci of basaltic volcanism (10 to 7 m.y.) along these fractures interfinger with the clastic wedge. A similar pattern of uplift and drainage reversal apparently heralded the onset of wrenching along the Calaveras trend 6 to 8 m.y. ago. Expansion of the strike-slip orogene segmented the outer fore-arc basin into local basins, some characterized by periodic lacustrine deposition and probable internal drainage. By the end of the Miocene, Sierran arc volcanism waned at the latitude of San Francisco Bay, and arc-derived volcaniclastics were fully supplanted by recycled Coast Range-derived detritus in the East Bay area. Certain of these Coast Range sediment sources, particularly blueschist-bearing Franciscan terranes, serve to constrain estimates of strike-slip on the Hayward fault.

Although tectonics provide the principal control on patterns and composition of Neogene sedimentation in the East Bay area, late Miocene climatic fluctuations left a marked overprint. Red beds, typical of the lower upper Miocene and suggestive of seasonal aridity, correlate with a relatively cold period along the northeast margin of the Pacific Ocean. In contrast, overlying middle upper Miocene fluvial-lacustrine beds are gray brown and contain abundant carbonaceous debris and faunas indicative of a marked decrease in aridity. These strata correspond to a period of warming in the later Miocene prior to latest Miocene refrigeration (Messinian).

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Stratigraphy and Sedimentology of Upper Miocene Williams Sand, San Joaquin Valley, California

The upper Miocene, late Mohnian age, Williams Sand crops out in the southeastern Temblor Range along the southwest margin of the southern San Joaquin Valley, California. The Williams is composed of lenses of generally coarse material within the siliceous Antelope Shale Member of the Monterey Formation and is stratigraphically equivalent to the Stevens Sand. The sands and shales were deposited in paleontologically defined waters as much as 4,000 ft (1,219 m) deep. Based on field and laboratory studies, the Williams is interpreted as a