in the reservoir rocks (Craig via White), the impoverishment of B in the reservoir rocks (White), and the similarity of the Rb/K ratios of the brines to those of arkosic materials indicate the high degree of interchange between the host rock and the thermal waters.

The Cl ion either must be introduced at depth as juvenile Cl transported solely by diffusion in the gaseous phase from a magmatic source or must result simply from the concentration of meteoric interstitial water of the sedimentary fill. Strong evidence suggests that no Cl-evaporites are present at depth in the graben. The similarity of the Br/Cl ratio of the thermal brines to all of the meteoric surface and ground waters of the Imperial Valley area (Chevron Research data) and its complete dissimilarity to ratios found within Cl-evaporites suggest that the brines are merely the meteoric water of the graben fill concentrated many-fold. No exotic source is needed.

Hyperfiltration of relatively dilute hydrothermal solutions through electrostatic semi-permeable membranes, composed of abundant montmorillonitic and illitic clays in the sedimentary fill, and probable zeolites overlying and laterally bounding the thermal anomaly, provides the best mechanism for concentrating the brines as well as determining their relative composition and that of the surface effluent waters overlying the thermal anomaly.

Such high concentrations could be achieved only by a very large volumetric transfer of dilute hydrothermal waters through the membrane material due to the progressive decrease of hyperfiltration efficiency of semi-permeable membranes with increasing concentrations. Relative hyperfiltration of Ca with respect to Na and the relative increase of B, NH_4, F, I, and HCO_3 in solutions effluent from membranes has been observed by White in subsurface waters at lower temperatures. The relative increase of K/Na and Cs/K by selective membrane transport in a hyperfiltrated solution is consistent with the known behavior of solutions through ion-exchange columns where the smaller hydrated ion is adsorbed preferentially in the double layer, thereby permitting preferential membrane transport for the larger and less hydrated ion.

A steadily expanding dome-shaped zone of brittle, fractured rocks metamorphosed by the hydrothermal solutions ascending by convective transport from a high heat source at depth, presumably a silica melt, and surrounded by relatively unmetamorphosed membrane materials (zeolites and clays) is assumed as a model. Hyperfiltration would occur within the dome by passage of solutions through the bordering membrane materials. Brines whose composition would have increased steadily through time until reaching an equilibrium would be found in the dome within which a convection cell characterized by channel flow should exist. Relatively dilute effluent solutions of a particular chemistry would emerge continuously from the membrane material to form the dilute shallow waters of specific chemical composition that typically occur near the surface at the Salton Sea and other thermal anomalies. Occasional fractures would permit leakage of the concentrated brine outward from the dome where it would mix with effluent waters. Meteoric interstitial water of the sedimentary fill would mix with the membrane-effluent and leakage waters on the borders of this hydrochemical system.

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GEOLOGIC HISTORY OF ALASKA PENINSULA

The Alaska Peninsula area is of particular geologic interest because it is part both of the Aleutian volcanic arc and the continental margin of southwestern Alaska. Topographically, the peninsula is a ridge, rising above the general level of a broad marine platform consisting of the Bering Sea shelf and the Shumagin-Kodiak shelf. However, the structural and stratigraphic history of these shelves appears to be separate from that of the Alaska Peninsula. The islands of the Shumagin shelf consist largely of a thick flysch sequence of late Mesozoic turbidites and volcanic rocks containing ultramafic bodies and are intruded by earliest Tertiary quartz diorite plutons. Similar rocks comprise the Kenai and Chugach Mountains.

The oldest dated rocks of the Alaska Peninsula are Permo-Triassic carbonate and volcanic rocks and Lower Jurassic volcanic debris, both of which were intruded by an Early Jurassic granitic batholith. Uplift and erosion of these rocks caused the appearance of the Alaska Peninsula, and the accumulated arkosic debris now constitutes a thick Middle Jurassic to Lower Cretaceous sequence. Middle Cretaceous deformation was relatively small-scale, but rocks of this age are absent from the Alaska Peninsula. Uppermost Cretaceous strata constitute a thin, but widespread, transgressive sequence.

Marine and non-marine volcanic rocks and debris accumulated to great thicknesses throughout the early Tertiary, especially in the outer parts of the Alaska Peninsula; lesser amounts were deposited on the newly uplifted Shumagin shelf. These were deformed gently at the time of mid-Tertiary plutonic intrusions along the present Pacific shore. Miocene debris from older rocks, as well as new volcanic material, accumulated in great thickness, but Pliocene strata occur only as thin patches of volcanic rocks in the mountains and as isolated bodies of marine sediments near the present coast. Both the Pliocene volcanic and sedimentary rocks rest discordantly on older rocks. All of the prominent structural features of the Alaska Peninsula were formed by post-Miocene deformation.

The Alaska Peninsula thus may have existed as early as Middle Jurassic time. The Shumagin-Kodiak shelf was formed during the earliest Tertiary. The Aleutian volcanic arc and trench are no older than Tertiary, and the trench may be relatively young. The greatest thickness of Tertiary sediments accumulated in isolated depressions that were only partly controlled by earlier structure, *e.g.*, in the Gulf of Alaska, Cook Inlet, Bristol Bay, and at the outer parts of the Alaska Peninsula.

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TEXTURAL TRENDS OF RECENT SEDIMENTS FROM RIVER TO ABYSSAL PLAIN OFF OREGON

Recent sediments from river to abyssal plain in the area of the central Oregon coast show distinct textural trends. Textural parameters were computed for more than 300 sediment samples from Yaquina River, Yaquina Bay, neighboring coastal beaches and dunes, and from the continental shelf, slope, and abyssal plain off Yaquina Bay.

Yaquina River sediments are poorly to well sorted, angular to subangular, and range in grain-size from silt to coarse sand. Sediments within the bay range in size from silt to medium-grained sand, are angular to subangular, and are poorly to well sorted. Beaches and dunes consist of well-sorted fine sand. Well-sorted, fine detrital sand covers the inner continental shelf (0-50 fms.), and grades laterally into poorly-sorted, glauconite-rich, clayey silt on the outer shelf (50–100 fms.). Clayey silt with small amounts of Foraminifera, radiolarians, diatoms, and sponge spicules covers the continental slope. Silty clay is predominant at the base of the slope of the abyssal plain (1,500 fms.).

From an areal standpoint, the beach, dune, and inner-shelf sediments are more uniform than those of the river, bay, outer shelf, and upper slope. Beach and dune sediments are best sorted. Within the bay, sorting is better toward the coast line. Most river and bay sediments are positively skewed; beach and dune sands mainly are negatively skewed. Offshore, the median diameter generally decreases with depth, and sorting becomes poorer. Skewness is negative for the inner-shelf sediments, positive for the deposits of the outer shelf and continental slope, and negative for abyssal-plain sediments.

Similarities of texture and fauna of Recent sediments with those of middle and late Tertiary rocks in the area indicate that comparable textural trends existed.

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SOUTHERN CALIFORNIA AND OFFSHORE TERTIARY BASINS

The pattern of southern California Tertiary basins has been formed, changed, and controlled by the trends of many major lateral faults. Their dominant northwest-southeast trends are interrupted by an ancient belt of east-west lateral faults which also caused basins to form across the region.

The structural pattern and, therefore, the erosional and depositional patterns were changing almost continuously during the Tertiary. Broad Eocene land and sea features were broken up by regional emergence and block faulting during the Oligocene. However, the general structural pattern lasted into early Miocene, when regional submergence began. Regional transgression continued through Miocene time, with few interruptions, over an increasingly irregular terrane formed by a developing complex fault-block pattern of basins and ranges. Great reversals of vertical relations between blocks and great lateral offsets occurred through Miocene and Pliocene times. Many islands or high land masses, deep embayments, and basins were formed at different times only to founder or be broken up. The depositional areas and types varied greatly and constantly with most of the coarser clastic sediments being deposited as submarine slides and turbidites.

New general block deformation ended the Miocene, and the Pliocene began with a different pattern of emergences, although many existing basins were deepened. Marine sediments of the entire region, because of this rapidly changing geography, were mostly coarse clastics derived from land; lithofacies became increasingly divergent and restricted. However, thick organic deposits were formed over large areas during times of greatest submergence in middle and late Miocene times. Considerable non-marine deposition occurred in coastal as well as interior valleys through Tertiary time except during early Pliocene. Most of the Tertiary basins were similar to those of the present. Even the ecology of some Tertiary basins is similar to that of modern basins, including the Gulf of California and the Imperial Valley.

The comparatively meager subsurface data from the 15,000-square-mile area offshore indicate that the same structural, erosional, and depositional histories took place there in the Tertiary as in the Tertiary basin region now emerged onshore. Offshore structural features are much less eroded or obscured, and sediments there are generally finer, thinner, and more organic.

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MIOCLINES IN SPACE AND TIME

Many continental margins are capped by wedge-shaped prisms of Cretaceous to Recent shallow-water marine strata. These prisms were deposited on downflexing continental margins, presumably subsiding because of regional isostatic compensation caused by the growth of adjacent continental-rise prisms. The writers equate these continental-terrace wedges with miogeosynclines of the past, which are wedge-shaped as now preserved and which probably were never synclinal in form—hence the shortened term "miocline." Modern mioclines thicken toward the ocean and terminate by "thickening-out" against water at the continental slope; it is presumed that ancient ones did also. Ancient mioclines thicken toward, and abut, a deformed eugeosynclinal lithofacies. These are interpreted to be collapsed continental rises deposited synchronously with the adjacent miocline and later accreted to the continent.

Mioclines probably have been formed by marginal sedimentation throughout geologic history, the outer limits being former continental boundaries before the accretion of new fold belts. The Appalachian miocline may be one Paleozoic example and the Millard miocline of the western United States may be another. More speculatively, Precambrian examples of mioclines may be the Huronian metasedimentary sequence abutting the Grenville fold belt in Canada and the Witwatersrand Series in South Africa.

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GRAVITY SURVEY AND ANALYSIS OF SAN DIEGO EMBAYMENT, SOUTHWEST SAN DIEGO COUNTY, CALIFORNIA[1]

A reconnaissance study of the San Diego, La Jolla, and western one-thirds of the El Cajon and Jamul 15-minute quadrangles was conducted to determine the depth to basement, using gravity meter, available well data, and surface geology. A Worden gravimeter was used to occupy 368 stations with ½-mile spacing; drift, latitude, and elevation corrections were made; basement-sediment density contrasts range from 0.3 to 0.5 mgals.

Geologic units and gravity contours trend north-northwest as do the Peninsular ranges. Anomalies over areas underlain by batholithic rocks range from –6 to –26 mgals. Irregularities and small closures occur along the belt of dense (±2.85 gm./cc.) Santiago Peak

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