depositional environmental interpretation is a sabkha near the bottom, an open marine in the middle, and shallow marine near the top representing a regression, transgression, and regression. The lowermost member of the Kaibab Formation, the Fossil Mountain, is a fossiliferous chert-bearing limestone with whole fossils and was deposited in a low-energy marine environment suggesting a transgression. Overlying the Fossil Mountain Member is the Harrisburg Member which consists of a series of alternating gypsiferous siltstones, dolomites, and limestones interpreted as having been deposited in an environment which fluctuated between a sabkha and shallow, open-marine seas.

Overlying the Harrisburg Member is the discontinuous Rock Canyon Conglomerate. It represents erosion and dissection of the Harrisburg Member and resulted from a major marine regression during Late Permian time.

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Sedimentology of Fluvial Upper Devonian Kanayut Conglomerate, Brooks Range, Alaska

The Kanayut Conglomerate, which extends across most of the Brooks Range in northern Alaska, is a widespread nonmarine clastic sequence as thick as 2,000 m. It records southwestward growth of a major fluvial-dominated coarse-grained delta. The Kanayut is underlain and overlain by fossiliferous marine strata of the Upper Devonian Hunt Fork Shale and Lower Mississippian Kayak Shale, respectively. It has been subdivided into four members, in ascending order: (1) a lower marine member, 560 m thick, consisting chiefly of sandstone; (2) a lower nonmarine member, 550 m thick, consisting chiefly of fining-upward cycles of sandstone to shale; (3) a middle nonmarine member, 450 m thick, consisting of massive interbedded conglomerate and sandstone; and (4) an upper nonmarine member, the Stuver Member, 400 m thick, consisting chiefly of fining-upward cycles of sandstone to shale. The distribution of maximum size of conglomerate clasts suggests a source area to the northeast, and paleocurrent measurements indicate sediment transport dominantly toward the southwest. The conglomerates are texturally and compositionally mature, containing primarily clasts of chert with lesser amounts of quartz, quartzite, and argillite. The sandstones are also compositionally and texturally mature, composed chiefly of subrounded grains of quartz, chert, and argillite, with negligible amounts of feldspar.

The Hunt Fork Shale, Kanayut Conglomerate, and Kayak Shale record a major progradational-retrogradational deltaic cycle. The lower marine member of the Kanayut and underlying and overlying marine units represent prodelta, delta-margin, and delta-front deposits, the lower nonmarine member and the Stuver Member of the Kanayut represents meandering fluvial delta-plain deposits, and the middle nonmarine member of the Kanayut represents braided fluvial delta-plain deposits.

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Geometry and Dispersal Patterns of Deep-Sea Fans From Various Tectonic Settings

Deep-sea fans range from small fan-shaped depositional bodies with relatively simple internal structure to large variably shaped depositional bodies with complex internal structure. Their shape depends on several important factors: (1) the topography of the basin floor and shape of the basin in which they are deposited; (2) the number and distribution of submarine canyons or sea gullies transporting sediment to the ocean floor; (3) the strength and direction of bottom currents; (4) the effects of the Coriolis force; (5) the grain-size distribution of the sediment being fed to the fan; (6) the rate of sediment supply; (7) the presence of syndepositional tectonism either along basin-margin slopes or on the sea floor; and (8) the position of the shoreline and effects of sea-level changes.

Fans in trenches can be extremely long and narrow, whereas those on flat ocean floors have more regular fan shapes. Fans fed by single submarine canyons are relatively simple, whereas those fed by sea gullies that extend outward from deltas are more complex. Bottom currents can redistribute fan deposits, and the Coriolis effect causes hooking of modern fan channels. Fans built primarily of sand from submarine canyons are highly channelized, whereas those containing a mixture of sediment sizes have well-developed non-channelized facies. The rate of sediment supply, strongly affected by sea-level changes and tectonism, provides overall constraints on the size and shape of fans.

Fans constructed along California-, Japan-, Andes-, and Atlantic-type margins have distinctive geometric, petrographic, and dispersal characteristics.

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Structural and Sedimentologic Study of Cerro Prieto Geothermal Field, Baja California, Mexico

Since 1977 the Comisión Federal Electricidad of Mexico and the Lawrence Berkeley Laboratory have cooperatively studied the Cerro Prieto geothermal field, located approximately 35 km south of the United States-Mexican border in the Mexicali-Salton trough.

As part of these studies, geophysical and lithologic well logs have been qualitatively and quantitatively studied using both manual and computer interpretation techniques. These logs were analyzed to make stratigraphic correlations throughout the Cerro Prieto field and to interpret the depositional environment of the field's lithologic units. Dipmeter and seismic data were of noted value in making stratigraphic interpretations and predictions. Cross sections were constructed to illustrate lithofacies variations throughout the geothermal field. These sections were used to construct a three dimensional model of the Cerro Prieto geothermal reservoir.

Petrographic, SEM, and X-ray diffraction analyses were made of the well bore cuttings to determine the degree and distribution of hydrothermal alteration, the origins of secondary porosity, and the relative degree of

fracture and dissolution porosity. These analyses were corroborated by log-derived formation fluid properties, porosity, and petrophysical data, and by petrophysical analyses of Cerro Prieto core conducted under in-situ conditions. The results of these studies were integrated into the Cerro Prieto reservoir model.

These studies have resulted in a better understanding of a major hydrothermal resource. This enhanced comprehension will contribute to the efficient development of not only this geothermal field but will serve as a model for development of similar resources.

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Study of Diagenetic Processes in Sandstone from Cerro Prieto Geothermal Field, Baja California, Mexico

The economic exploitation of a geothermal resource is dependent on an adequate reservoir porosity and permeability and awareness of the distribution of each during development. Exploitable reservoir porosity and permeability are the results of diagenetic alteration of the reservoir's original porosity.

In this study, we have used petrographic, SEM, and X-ray diffraction analysis of well-bore cutting and core to model the diagenetic processes evident in the Cerro Prieto geothermal field. Porosity distribution was matched with lithologic and hydrothermal alteration distribution and a composite distribution model was constructed. This model was then analyzed for porosity trends.

The ratio of fracture to dissolution porosity and the ratio of detrital dissolution secondary porosity to authigenic dissolution secondary porosity were critical to this study. The role of fracture-dominated porosity and authigenic mineral plugging may have been overstated in geothermal system development.

The role of diagenetic studies in any reservoir evaluation is paramount. Diagenetic processes determine porosity from its origins through to distribution of porosity and permeability. Studies of these processes will contribute to better prediction of reservoir porosity distribution and subsequently better management of the geothermal resource.

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Eastern Cordilleran Foldbelt and Foreland of Northern Canada

The eastern Cordilleran foldbelt and foreland of Canada north of lat. 60°N lies between the Tintina trench and the Canadian shield. It includes part of the southern rim of Canada basin and the junction between the Cordilleran and Innuitian orogenes. The sedimentary succession rests with profound unconformity on the westward continuation of the crystalline rocks of the shield, tapering eastward to a zero edge against the shield but truncated northward at the outer edge of the continental shelf. Widespread unconformities within and beneath the succession attest to regionally episodic orogeny and epeirogeny from the Proterozoic into the Tertiary.

In contrast to the tectonic style of equivalent thrust-faulted parts of the southern Canadian Cordillera, the region is characterized by bundles of right- and left-hand en echelon folds cut by two major, right-lateral strike-slip fault systems, the Richardson fault array bordering upon the foreland, and the Kaltag fault zone transecting the foldbelt. Laramide horizontal shortening with concomitant vertical thickening of the sedimentary succession is roughly one-fourth that at the 49th Parallel.

Known reservoir rocks for hydrocarbons include lower Paleozoic platformal carbonate rocks just north of lat. 60°N in both the foreland (Rabbit Lake) and eastern margin of the foldbelt (Beaver River and Pointed Mountain); Middle Devonian reefs (Norman Wells) and lower Carboniferous sandstone traps (Chance) within the foldbelt; and most recently, shale-cored anticlines and growth-fault structures in the Tertiary clastic sequence on the continental shelf at the junction of the Cordilleran and Innuitian Orogens.

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Sand Dispersal at Norderneyer Seegat, West Germany

Norderneyer Seegat connects the North Sea and the Wattenmeer between the East Friesian Islands of Juist and Norderney. It is a high wave-energy mesotidal inlet. The mean tide range is 2.4 m and the estimated mean breaker height exceeds 1 m. The sediment dispersal pattern and resultant morphology differ significantly from those of mesotidal inlets investigated along the low wave-energy shores of the southeastern United States.

The seaward margin of the ebb-tidal delta consists of a nearly continuous arc of bars, the "reef-bow." These bars have segregated tidal flow; flood dominates a broad ramp facing into the dominant waves (i.e., the west side), ebb dominates the narrow steep leeside margin. The bars migrate eastward through combined tide and wave action at an average rate of 400 m/year. Bar migration appears to be the dominant mode of inlet sediment bypassing.

The gorge section of the main inlet channel is ebb-dominated as a result of (1) water level-dependent inlet efficiency and (2) net water supply to the inlet drainage basin due to prevailing southwest winds.

Flood-dominated intertidal sand shoals abound in, and landward of, the inlet gorge. Ebb-dominated flanks occur on some of the shoals. The degree of flood dominance increases landward, an effect which is attributed to the difference in celerity between the tidal wave trough and crest.

Both the mechanics of ebb-delta sand bypassing, and the occurrence of tidal-flat flood dominance, distinguish the dispersal pattern at Norderneyer Seegat from that at mesotidal inlets with lower wave energy. Stratigraphic models for tidal-inlet sequences must consider both tide range and wave energy.

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