dom if ever used as an exploration tool. The problem with these previous studies is that they concentrate on grain-size parameters for individual samples, and fail to recognize that various depositional environments are characterized by a number of discrete facies, each with its own characteristic sedimentary structures and grain-size populations. For that reason, vertical progressions in grain-size data are far more diagnostic of depositional environment than are scatter diagrams in which one grain-size parameter is plotted against another.

Grain-size progressions for ancient sequences of the Upper Cretaceous Point Lookout formation and Eocene Queen City Formation demonstrate the value of the technique. The data show that distinctions can be made between fluvial, estuarine/tidal distributary, flood-tidal delta, foreshore, and shoreface sandstones. More importantly, our method relies on analysis of samples collected at random intervals (generally 2 ft or .6 m), so that it is applicable where sidewall cores are available. Diagenetic complications (other than those resulting from silica cementation) do not appear to threaten the sensitivity of the method. Using automated settling analysis, these data are obtained rapidly and can aid in subsurface correlation as well as determining the depositional environments of sandstones.

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A Model for Evolution of Small Pull-Apart Basins

A preliminary model for the evolution of small extensional or pull-apart basins is presented. The very rapid subsidence, sediment accumulation, and hydrocarbon maturation observed in many basins of this type are explained using a McKenzie-type approach. Lateral heat loss is shown to be a critical factor in controlling the rate of heat loss in basins of finite width. In a simple two stage model where stretching and cooling are assumed to occur as separate processes, more than one-third of the total thermal subsidence occurs in the first 200,000 yr of cooling for a basin 30 km (20 mi) across. This allows for the accumulation of over 2 km (6,500 ft) of sediment. Because the time required for a 10-km (6-mi) long block to be stretched to 30 km (20 mi) is substantially greater than 200,000 yr, much of the cooling and subsidence must take place during stretching. This simultaneous stretching and cooling is approximated by alternating short periods of stretching and cooling.

The resulting model is applied to the development of the basins associated with the San Andreas fault in southern California. These basins have recently (Miocene to Present) undergone rapid (up to 6 km, 4 mi) subsidence and sediment accumulation as well as rapid maturation of hydrocarbons. They appear to have been initiated in an extensional regime along irregularities in the strike-slip motion of the fault, even though some of the basins have been modified by subsequent compression. These basins are therefore excellent candidates for testing the proposed model.

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Multi-Disciplinary Approach to Biostratigraphic Mapping—Two Case Studies: Bass Basin, Australia, and North Soldado, Trinidad

Palynologic zones were used to subdivide the Late Cretaceous to late Eocene beds in the Bass basin, Tasmania, Australia and the Late Miocene to Pliocene beds in the S.484/S.498 area, North Soldado, Trinidad. These zones are related to discrete genetic sedimentary cycles bounded by unconformities which are marked by abrupt changes in the environment of deposition. In both areas, the environments range from shallow marine to continental.

Owing to wide sample spacing (up to several hundred feet in some wells), it was impossible to locate precisely each biostratigraphic boundary, based on palynological data alone. The composite use of sedimentology, wire-line log characteristics, dipmeter interpretation, and reservoir fluid properties was integrated with the palynologic data, providing a practical technique that was used to delineate the sequence boundaries in wells where spore-pollen data was inadequate.

This method enabled the development of accurate zonation and a detailed correlation between wells within both the Bass basin and the S.484/S.498 area.

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Distribution of Organic Richness in Time and Space

Distribution of organic facies is related to interaction between productivity and preservation, both the consequence of environmental factors. The environment also controls the amount and type of the organic matter present and its potential to yield hydrocarbons.

A conceptual model for predicting organic richness in time and space is based on predictions of the geographic location of high marine organic productivity by upwelling systems during intervals of optimal preservational potential within transgressive cycles. Whether or not the marine organic matter is in fact preserved in the rock record depends on the spatial relationship of the upwelling system to potential environments of preservation. The problem of preservation is addressed at two levels. The first is whether or not a depositional basin was in the proper geographic position to receive the organic matter during a sediment accumulation cycle, and second, whether or not that organic enriched interval is preserved in the stratigraphic sequence of the basin.

Prediction of basin location is derived from plate tectonic reconstructions. Prediction of productivity is based on paleogeographic and paleoclimatic models. Presence or absence of potentially organic-enriched rock units is evaluated by examination of the stratigraphic record of the basin being studied. Measuring actual levels of organic content of the rocks must be done with sample analysis.

The conceptual model for predicting the temporal and spatial distribution of organic richness derived from marine upwelling systems is simplistic by necessity. It focuses on primary parameters and addresses only a few secondary parameters. Success or failure in making predictions with this model in basins already understood can test the validity of the model and which parameters are most important.

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Oblique-Slip Sedimentation and Deformation in Nonacho Basin (Early Proterozoic), Northwest Territories, Canada

The Nonacho basin shares several traits with molassoid basins formed in oblique-slip settings: (1) great thicknesses (about 9 km, 6 mi) of siliciclastic sediments deposited in alluvial fan, fan-delta, braided stream, beach, deltaic, and lacustrine environments; (2) synsedimentary faults which activated nearby sources; (3) rapid sedimentation and subsidence; (4) telescoped facies transitions, particularly adjacent to active faults; (5) extremely variable thicknesses of lithostratigraphic units; (6) diachronous sedimentation resulting from the migration of source areas and sites of sedimentation along deformation fronts; (7) mobility of deposition and deformation such that early sediments were uplifted, cannibalized, and redeposited; (8) paleocurrents directed basinward near basin margins, and longitudinally in axial regions; (9) lower greenschist facies metamorphism; (10) paucity of volcanic rocks; and (11) complicated structural geometries. However, these features alone are not diagnostic of oblique-slip origin; all are compatible with rift, aulacogen, impactogen, retroarc, peripheral, intramontane, and broken foreland settings. More reliable indicators of an oblique-slip tectonic setting for the Nonacho basin are: (1) anastomosing pattern of near-vertical, en echelon faults which delineate rhomb-, wedge-, and rectangular-shaped semi-independent subbasins and basement uplifts; (2) stretching lineations of shallow to moderate plunge along shear zones; (3) folds and near-vertical penetrative fabrics, related to shear zones, but at angles of 20°-30° to these zones. The Nonacho basin fill is interpreted as a foreland molasse of the Trans-Hudson orogene. Deposition and deformation probably occurred in response to convergence accommodated by oblique slip, analogous to the Tarim and Tsaidam basins of China, which developed in the late stages of India-Eurasia collision, north of the Tibetan Plateau.

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Dakota Sandstone Facies, Western Oklahoma Panhandle

The Cretaceous Dakota Sandstone in Cimarron County comprises three sandstone units and intervening mudrocks; it overlies the Kiowa