(and migration direction) and the resultant effective wind vector may have significant implications for paleowind analysis in the geologic record. In this instance, the structure reflects only west-southwest (July-December) winds, owing to a southwest-northeast imbalance in sand movement. This imbalance is due mainly to the effect of sand-trapping by vegetation on northeast slopes, as well as to seasonal differences in sand mobility, the latter correlating partly with the semi-annual shift in the wind regime.

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Neogene Deep-Living Radiolarian Zonation and Its Uses

A Neogene radiolarian zonation using deep-living radiolarians has been developed. This zonation consists of 6 radiolarian zones with the nominant taxa of each zone first occurring at the base of its zone, and that nominant taxa running throughout its zone. These zones are the *Eucyrtidium cienkowskii* (22.5-19 Ma), *Siphocampe arachnea* (19-14 Ma), *Oroscena* with digitate spines (14-11 Ma), *Botryostrobus bramlettei* (11-6 Ma), *Clathrocyclas bicornis* (6-2.5 Ma), and *Cycladophora davisiana davisiana* (2.5-0 Ma) Zones. These zones were developed by using Antarctic, equatorial, and North Pacific Deep Sea Drilling Project holes, and are believed to be cosmopolitan zones due to their being based on deep-living radiolarians. These zones are dated by correlating the first occurrences of the nominant taxa with warm-water radiolarian datums that have been paleomagnetically dated. These zones are not designed for routine use, but rather for tying together other more provincial zonations, and for comparing oceanographic phenomena on global datum planes. To date, this zonation has been used to correlate Antarctic zonations intra- and inter-regionally and to study the evolution of radiolarian lineages.

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Uses of Vitrinite Reflectance in Determining Thermal History in Sedimentary Basins

Vitrinite reflectance (VR), adapted from coal petrology, came into routine use in the petroleum industry in the late 1960s. Initially, the principal goal was to help establish the VR limits for oil and gas generation. Subsequently, VR has become accepted as the most useful measure of burial history and paleotemperature, largely because VR affords the most practical means of measuring the progression of organic metamorphism. VR is used to correlate other measures of thermal history such as chemical maturity parameters, Rock-Eval $t_{max}$, and burial-history reconstruction. VR can aid in identifying unconformities, geopressured sections, and thermally altered zones. Combined with good temperature data, the determination of VR equivalents from temperature and burial time are used to evaluate the relationship of depth to log VR obtained directly. The time and temperature required for maturation in Tertiary basins stresses the interplay of both factors in the maturation process. Reflectance has been employed in deciphering the burial history and tectonic evolution of many areas, including structurally complex regions as the Alps and the Wyoming Overthrust belt.

Interpretational problems that arise include: (1) VR can be altered by the absorption of hydrogen-rich materials, oxidation, and natural coking; (2) the presence of reworked and caved organic matter produces multiple reflectance populations; and (3) vitrinite is sometimes difficult to distinguish from solid hydrocarbons and some inerts if the particle size is small. Most of these problems are resolved at the microscope. Interpretation is improved significantly by analyzing a series of samples rather than an isolated sample.

CHANG, HUNG K., and RENATO O. KOWSMANN, PETROBRAS, Rio de Janeiro, Brazil

Thermal Subsidence of Santos and Sergipe-Alagoas Basins, Brazil—Application to Hydrocarbon Exploration

A uniform lithospheric extension model has been applied to the subsidence and thermal history of the Santos and Sergipe-Alagoas basins. Thermal subsidence curves were derived from more than 40 exploratory wells, complemented by seismic and gravity sections.

In the Santos basin, the region landward of the hinge zone is dominated by Tertiary marine onlapping sediments. Seaward, rift (continental) and postrift (transitional and marine) sequences are present with predominance of the latter. Crustal thinning by 35% exists just east of the hinge zone and increases to 70% at the shelf break.

Likewise, the hinge zone in the Sergipe-Alagoas basin overlies the largest gradient in crustal thinning, but unlike the Santos basin, rift-stage sediments dominate landward of this hinge zone. Seaward, the ratio of rift to postrift sediments is larger than in the Santos basin. Crustal thinning ranges from 20% to 60%, but this transition occurs over a short distance.

Thermal and burial histories were used to estimate oil windows for potential source rocks in various parts of these basins. Maturation profiles are in good agreement with observed vitrinite reflectance and hydrocarbon maturity data. The areal distribution of maturation stages through time is variable and largely controlled by crustal thinning. Information on timing of hydrocarbon generation was applied to the prediction and evaluation of hydrocarbon accumulation.

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Uniformitarian Hypothesis to Explain Permian-Triassic Life Extinctions

A uniformitarian hypothesis is possible to explain the great Permian-Triassic life extinction event. Unlike the recent "catastrophic" explanations for the Mesozoic-Cenozoic extinctions, this hypothesis does not depend upon extraterrestrial intervention.

The dominant worldwide event at the close of the Paleozoic was the formation of Pangea. The Mesozoic witnessed the sundering of this supercontinent and the formation of the modern continental masses and oceans.

The areas covered by the waters of the Paleozoic oceans surrounding Pangea either were incorporated onto the fringing continents or were subducted. New oceans, which became the present oceans, were forming in the Mesozoic in the areas where the combined continental masses were splitting apart.

If these 2 events were in part simultaneous and yet physically separated in such a way that the waters in the newly forming oceans did not connect with the water in the closing oceans, almost complete extinction of all earlier marine life forms would result.

Radioactive dating of the present ocean floor indicates that the Paleozoic floor was eliminated, and new ocean floor began to form in the Mesozoic. Chemical dating of present ocean water indicates that its time of origin is approximately the same as that of the present ocean floor.

CHAPMAN, WILLIAM H., Exxon Co., U.S.A., Houston, TX

Computer-Generated Reconnaissance Maps Using Commercial Data

Much well and production-history data are currently available in digital form from commercial sources. These data, when mapped using a computer, can quickly give valuable perspectives to the geologist developing new prospects.

A large data bank has been built from commercial well and production data that can be reported or mapped using either proprietary or commercially available software. Time and manpower reductions experienced using the computer-generated maps give the geologist the ability to evaluate large geographical areas before committing resources to potential prospects. These maps can include not only conventional geologic maps, such as isopach and structure maps, but also maps of abnormal pressure, bottom-hole temperature, or any geologic parameter contained in the data bank.

CHIA, YEE-PING, ARCO Oil & Gas Co., Dallas, TX

Numerical Simulation of Subsurface Flow in a Sedimentary Basin

Pore water in sedimentary rocks is normally in motion. In general, gravity-induced flow driven by the elevation gradient predominates in a basin with orogenic deformation; however, in a basin with continuous deposition, compaction-induced flow driven by the excess fluid-pressure gradient predominates. Subsurface water flow is considered to have a controlling influence on the migration of widely dispersed petroleum. Therefore, the analysis of a basin-wide flow system, particularly its paleohydrogeologic conditions, is essential for understanding the history of petroleum migration and entrapment.

The nonlinear finite element method has been used to simulate coupled processes of sediment deformation and fluid flow in sedimentary