complete reservoirs.

Identifying zones with a consistent and continuous log response greatly aids manual log interpretation. It also provides a valid means of data reduction for the first passes of a computer-processed interpretation because an interpretation model may be tested by treating a limited, yet representative, number of points. Cross-plot interpretation can also be simplified by using the electrofacies type on the z-axis, and displaying averaged log values for each electrofacies.

The FACIOLOG approach is designed not to compete with conventional facies analysis but to put electric logs into a framework which the geologist can easily integrate with his own studies and thereby squeeze the maximum amount of geological information out of them.

LLOYD, R. MICHAEL, Consultant, Houston, TX

"Transgressive" Pore-Filling Calcite, Cretaceous of South Texas

Early marine cementation and subaerial leaching of Stuart City rudist reef facies in south Texas yielded a rock with substantial intergranular, moldic, and shelter porosity. Most of this porosity was subsequently filled with a mosaic of blocky calcite, resulting in a tight rock. A detailed study integrating transmitted light and luminescent petrography with electron microprobe and stable isotope analysis reveals that the pore filling occurred in three stages representing distinctly different diagenetic environments. All three stages are seen commonly in single syntaxial crystals, suggesting continuous crystal growth while the environments were changing.

A model consistent with the data would have the following sequence of events: (1) initiation of calcite druse on pore walls in a freshwater phreatic environment, (2) continued pore filling in the phreatic mixing zone, and (3) final pore filling in the "marine" saline phreatic zone. The sequence could have occurred during a single, transgressive submergence of the pore system.

LOHMANN, KYGER C., Univ. Michigan, Ann Arbor, MI

Role of Fluid Inclusions in Diagenesis of Metastable Marine Cements

Early diagenesis of metastable marine cements occurs through a phase of dissolution along intercrystalline boundaries which is accompanied by precipitation of low magnesium calcite (LMC) within enlarged intercrystalline pores. This LMC cement is a luminescent phase complexly intergrown with non-luminescent, corroded crystallites of the precursor fibrous marine cement. This intergrowth results in early coalescence of the multicrystalline cement, which effectively isolates metastable phases from open chemical exchange with ambient pore waters during subsequent diagenesis.

Closure of the diagenetic system during subsequent stabilization is indicated by the preservation of chemical signatures retained within final calcitized products. Multiple carbon and oxygen isotopic analyses of a single generation of marine cement, for example, define strongly covariate compositional trends that reflect varying mixtures of the luminescent and non-luminescent calcites which presently comprise the stabilized marine precursor. End-member compositions of such trends reflect the compositions of intergrown LMC and precursor marine cement, respectively. Although early coalescence provides for closure of the chemical system, it does not prevent ultimate stabilization of metastable phases to LMC. Importantly, metastable relics are not preserved in ancient marine cements.

From all available data on solid-state processes, we infer that, at diagenetic temperatures, water is a required diagenetic medium to effect transformations of aragonite and high magnesium calcite phases to LMC. If, however, water is involved in this stabilization process, how is it possible to maintain a chemically closed system? An abundance of associated fluid inclusions is characteristic of fibrous cement mosaics. Such fluids, trapped along intercrystalline boundaries during early coalescence, migrate through the metastable host. As metastable phases dissolve, driven by their solubility difference with LMC, they concomitantly precipitate LMC, which paramorphically replaces the precursor cement. Such a mechanism not only provides for the retention of overall crystal fabric, via a submicron dissolution-precipitation process, but also provides for the maintenance of chemical signatures of the dissolving, metastable precursor cements.

LOPEZ, CYNTHIA M., Shell Oil Co., Houston, TX

Early Diagenesis of Sands and Sandstones from Middle America Trench and Trench Slope, Offshore Mexico and Guatemala

Siliciclastic sediments from the northern and southern segments of the Middle American Trench are distinctive both petrologically and diagenetically. Samples of terrigenous sands recovered in piston and DSDP cores from the continental margin of southern Mexico are primarily arkose and lithic arkose of plutonic and metamorphic provenance. Accessory constituents and diagenetic features are useful criteria for distinguishing sands from different tectonic provinces along the Mexican (northern) segment of the trench. Basal, early Miocene sandstones from the upper- and middle-slope regions (continental block) contain abundant skeletal grains and are cemented by calcite or gypsum. Early Pliocene to middle Miocene sands from the accretionary wedge are weakly lithified and contain fractured framework grains. Unlithified trench sands of Quaternary age have undergone significant pore-space reduction at very shallow burial depths.

Samples of Holocene terrigenous sands recovered in piston cores offshore from central Guatemala (southern segment) are feldspathic litharenite and litharenite of volcanic provenance. Authigenic pyrite is ubiquitous in these sands, and pore-filling phillipsite occurs locally. Partial dissolution of glass fragments, pyroxene, and plagioclase has occurred in sands from every environment sampled.

The differences observed in sands from the two segments of the Middle America Trench may also characterize siliciclastic sediments deposited along other segmented convergent margins. Within a trench segment, changes in sand composition with time could indicate intermittent volcanic activity and changes in relative sea level.

LORENZ, JOHN C., Sandia National Laboratories, Albuquerque, NM

Determination of Widths of Meander-Belt Sandstone Reservoirs from Vertical Downhole Data

Once it has been determined that a meandering fluvial model is applicable to a formation, paleohydrologic reconstructions can be applied to downhole measurements to derive sand body widths. The nonmarine part of the Mesaverde Formation in the east-central part of the Piceance Creek basin of northwestern Colorado was deposited in a predominantly meandering fluvial system. This interpretation is based on the presence of lateral accretion beds and multi-story sand bodies in outcrops along the Grand Hogback. It is supported by fining-upward trends in cores and gamma ray logs from the wells of the U.S. Department of Energy's Multi-Well Experiment being conducted near Rifle, Colorado.

Paleochannel depths, recognized from the heights of fining-upward trends in cores, can be converted to channel widths using Leeder's 1973 formula. The resulting channel widths are used to calculate meander belt amplitudes (sandstone body widths) from relationships derived from Leopold and Wolman's 1960 empirical data.

These numbers can be compared with sandstone body widths derived by two other methods. (1) Point-bar dimensions measured in outcrops can be used to calculate channel widths, which are then converted to meander-belt amplitudes as described above. (2) The MWX-2 well is offset from MWX-1 by 135 ft (41 m) at the surface, allowing for positive well-to-well correlation of sandstones. The percentage of sandstones which are penetrated by both wells is used as a probability to derive an average sand body width.

These last two methods give compatible results. The first method described, however, predicts comparatively narrow widths, suggesting that channel depths derived from fining-upward sequences in cores are not fully representative of ancient channel depths due to incomplete preservation. A preservation potential factor may be added to Leeder's formula for working with ancient sediments, so that the formula gives comparable results to the other two methods.

LOUCKS, R. G., Cities Service Exploration and Production Research, Tulsa, OK

Distinguishing Diagenetic Environments of Equant Calcite Cementation: Example from Lower Cretaceous Pearsall Formation in South Texas

Equant calcite is the most common cement in limestones. It occludes more pore space, and hence has more control over reservoir quality than any other carbonate cement. It is important, therefore, to be able to delineate the environments of precipitation of equant calcite cements. The Lower Cretaceous Pearsall formation in south Texas has a history of equant calcite cementation that began early in the shallow-subsurface meteoric environment and is continuing today in the deep-subsurface basinal environment. Trace-element analysis of Mg^{+2} and Fe^{+2} along with morphological characteristics of the Pearsall equant calcite cements delineate environments of precipitation.

Cements precipitated in the early, shallow-subsurface meteoric environment are generally very fine to medium-crystalline equant (less commonly bladed) calcites. The very fine to fine-crystalline calcite cement generally rims grains and is gradational into the medium-crystalline equant calcite cement that fills intergranular and moldic porosity. Early cements commonly have irregular crystal boundaries as seen in thin section.

Late, deep-subsurface precipitated cements are generally coarse to very coarse-crystalline equant calcites. Commonly they have straight crystal boundaries and form one or several large crystals in a pore space. There is generally a sharp change in crystal size with the fine to medium-crystalline equant calcites precipitated in the shallow-subsurface meteoric zone.

Trace-element analysis (electron microprobe) shows a statistically valid difference of Mg^{+2} and Fe^{+2} content between the early and late equant calcite cements. The early calcite cements have a higher Mg^{+2} content (1.8 ±0.3 mole % $MgCO_3$) and a lower Fe^{+2} content (785 ±184 ppm) than the late calcite cements (1.3 ±0.3 mole % $MgCO_3$ and 2.618 ±1,952 ppm Fe^{+2}). Also, semiquantitative probe analysis, due to low count rate, indicates that the early calcite cement is richer in Sr^{+2} (738 ±286 ppm) than the late calcite cement 472 ±189 ppm).

Magnesium in the fine-crystalline rim cement shows a pronounced trace-element distribution pattern. In the incipient crystal growth next to the grain, a high Mg^{+2} peak usually occurs, followed by a decrease in Mg^{+2} in the late rim cement and coarser equant calcite cement. This initial high Mg^{+2} peak is attributed to early meteoric diagenesis as described by Benson in 1974 in meteoric cements from Barbados. The Fe^{+2} trace-element distribution pattern shows an opposite trend from that of the magnesium. The early cements show low Fe^{+2}, whereas the late cements are Fe^{+2} rich, indicating a reducing environment of precipitation for the late cements.

Early, shallow-subsurface equant calcite cements can be distinguished from late, deep-subsurface equant calcite cements by relative position in pores, crystal size, straightness of crystal boundaries, gradation between crystal sizes, and by trace-element content and distribution patterns. These parameters may be valid environmental indicators of equant calcite precipitation in other limestone formations.

LOUTIT, T. S., G. R. BAUM, and R. C. WRIGHT, Exxon Production Research Co., Houston, TX

Eocene-Oligocene Sea Level Changes as Reflected in Alabama Outcrop Sections

Outcrops at Little Stave Creek and St. Stephens Quarry in southwestern Alabama contain continuous sections across the Eocene-Oligocene boundary. The sequence of lithologic and biologic changes recorded across the boundary in Alabama can be best explained by a rising sea level. From the base to top, the sequence consists of: silty glauconitic marl (Pachuta); glauconite marl (Shubuta); thin glauconitic clay (unnamed); glauconitic clay and marl (Red Bluff) interbedded with silty limestone (Bumpnose); and grading upward into a carbonaceous clay (Forest Hill). The last occurrence of the planktonic foraminifera *Globorotalia cerroazuleisis cocoaensis* occurs just below the top of the Shubuta marl. The last occurrence of the calcareous nannofossil *Discoaster saipanensis* is within the Pachuta. Lithologic and paleontologic studies indicate that the Pachuta-Shubuta units represent a deepening-upward sequence. As water depths increased, the locus of terrigenous deposition moved updip or shoreward of the sections at Little Stave Creek and St. Stephens Quarry, resulting in the production of a compressed marine sequence capped by a nondepositional marine hiatus. During and after the period of deepest water, renewed terrigenous deposition resulted in a shallowing upward sequence (Red Bluff, Bumpnose, and Forest Hill).

We suggest that: (1) the changes in water depth and sedimentation in the Alabama sections occurred as a result of a rapid rise in relative and eustatic sea level (Pachuta, Shubuta), reaching a maximum during the time of deposition of the unnamed blue clay, followed by a period of less rapid relative rise and slow eustatic fall (Red Bluff, Bumpnose, Forest Hill); and (2) the decrease in sedimentation rates (and hence a decrease in stratigraphic resolution) caused by a rapid rise of eustatic sea level may also account for the apparently synchronous first and last appearances of a number of microfossil lineages at the Eocene-Oligocene boundary in Alabama and elsewhere.