by subscriptions from the energy industry and from time to time selected results have been published. We report palinspastic reconstructions for the present Arctic region through Phanerozoic time with a tectonic commentary.

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Carbonate-Cement Stratigraphy of Burlington Limestone (Osagean) of Iowa: Evidence for Eh Gradients in a Regional Mississippian Paleogroundwater System

Cathodoluminescent petrography of calcite overgrowth cements in crinoidal grainstones from the Burlington Limestone reveals compositional zoning, which suggests that a chemical gradient was effective during cementation. These syntaxial calcite cements have as many as 7 luminescent zones. On the basis of these zones, a regional cement stratigraphy has been established among 22 measured sections within a 5,000 mi^2 area in southeastern Iowa. Overgrowths are interpreted as freshwater phreatic-zone precipitates. Comparison of the characteristic luminescent signature of Burlington calcite cements with cements in underlying Kinderhookian and overlying Meramecian limestones suggest the Burlington formed during, or before, the regional mid-Meramecian (sub-St. Louis Limestone) hiatus.

Early nonferroan calcite cements show a pronounced basinward change in luminescent zoning. Updip cements consist of 4 distinct compositional zones. In contrast, downdip cements contain only a single luminescent zone. Zonal distribution may have formed when cementation occurred along an Eh gradient within a fresh or phreatic-water system during exposure in mid-Meramecian time. Updip recharge areas were characterized by alternating oxidizing and reducing conditions, resulting in a sequence of luminescent (low Eh) and nonluminescent (high Eh) cement zones. Downdip, away from recharge areas, contemporaneous cements have only a single luminescent zone, which formed under continuously reducing conditions. The recognition of Eh gradients that were effective during carbonate cementation enables paleoflow paths to be determined, and aids in the prediction of diagenetic trends.

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Sodium Distribution in Eocene Dolomites from Castle Hayne Limestone, North Carolina

An 11-m section of the bryozoan biomicridite facies of the Castle Hayne Limestone in the Martin Marietta quarry, New Hanover County, North Carolina is locally dolomitized. About 6.5 m below the overlying unconformity, a 1.0-m zone consists entirely of sucrosic dolomite. The percentage of dolomite decreases fairly uniformly above and below this zone, and 3.6 m below the upper unconformity, the unit is undolomitized. The dolomite is nonferroan and occurs as fine anhedral to subhedral crystals. Above and below the zone of maximum dolomitization, the dolomite selectively replaces the micrite matrix. Where dolomitization increases toward a maximum, calcite allochems are replaced.

Acid-soluble sodium ranges from a low of 252 ppm in calcite to a high of 1,500 ppm in dolomite. Microprobe analysis revealed that sodium is concentrated in heulandite-group zeolite. The interlocking nature of the dolomite and zeolite crystals, the euhedral morphology of the zeolite, and the strong positive correlation between percentage of dolomite to sodium concentration suggest that both mineral phases are authigenic and formed penecontemporaneously from an open-system, stratified fluid (Dorag).

Unless the sodium distribution can be documented, these data suggest that whole-rock sodium concentrations in ancient dolomites may not be an accurate indicator for hyposaline versus hypersaline dolomitization. Dolomitization in proximity to the overlying subaerial unconformity has greatly enhanced postdepositional permeability in the micrite facies of the Castle Hayne Limestone. Dorag dolomitization caused by a lowering of eustatic sea level in conjunction with favorable hydrologic and lithologic conditions can have a profound effect on reservoir properties and permeability distribution in ancient carbonates.

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Petrology, Stratigraphy, and Depositional Environments of Burnt Bluff Group in Michigan

Recent discoveries of sizable natural gas deposits (production at least 1 MMCFGD/well) in 3 widely separated areas of Michigan have touched off exploration interest in the lower Middle Silurian Burnt Bluff Group. The Burnt Bluff and Manistique Groups are stratigraphically equivalent to the better known Clinton Group.

Analyses of core samples, outcrop samples, and wireline logs allow for a preliminary reconstruction of facies relationships and depositional environments. Where thickest, in northeastern Michigan, the Burnt Bluff Group can be divided into 3 formations: Lime Island Dolomite, Bryon Dolomite and Hendricks Dolomite. To the southwest the group thins dramatically to a single lithologic unit. The Lime Island and the Hendricks Dolomites represent shallow subtidal facies with abundant large, whole bioclasts of corals, stromatoporoids, and brachiopods. The Bryon Dolomite is a thinly laminated intertidal and supratidal carbonate with desiccation cracks, algal laminae, and anhydrite nodules.

Presently, natural gas production is found only in slightly dolomitized portions of the subtidal bioclastic facies in the Burnt Bluff. Porosity development is the key to production and is primarily solution-enlarged interparticle porosity restricted to the Hendricks and Lime Island Dolomites.

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Sedimentary Basin Thermal Histories Through $^{40}Ar/^{39}Ar$ Analysis of Detrital Microcline

The $^{40}Ar/^{39}Ar$ age spectrum technique has the demonstrated ability to resolve gradients of $^{40}Ar^*$ within crystals resulting from geologic heatings. A practical application of this observation is the analysis of detrital microcline from sedimentary beds to assess the source age of the feldspar, the time of basin heating, and the thermal intensity of the heating event. This intensity of the heating event is available through knowledge of the amount of $^{40}Ar^*$ lost from the sample and the temperature-dependent rate of argon transport within microcline. Both of these parameters are obtained as a by-product of the age spectrum experiment.

Results from a variety of sedimentary basins are encouraging and demonstrate the quality of information available from this technique. $^{40}Ar^*$ gradients in samples from the Basin block of the southern San Joaquin Valley, California, indicate a heating duration of 500,000-1 m.y., which is consistent with the stratigraphy. In conjunction with the present heat-flow data, these results suggest an equilibrium thermal gradient ~7°C/km higher than that presently observed—a consequence of rapid burial. K-spar separates from deep drill holes in the Albuquerque basin, New Mexico, reveal age spectra characteristic of substantial $^{40}Ar^*$ loss. Thermal calculations based on these data indicate a simple conductive history for samples above a present depth of about 6 km, although hydrothermal activity is evident in deeper material. Microcline separates have been obtained from a Kimmeridgian Sandstone (Tartan field, North Sea basin) that has been displaced about 1 km by a normal fault. Age spectra from these samples reveal minor $^{40}Ar^*$ losses of 4 and 6% from the samples in the upthrown and downthrown blocks, respectively. These loss profiles correspond to temperature histories that agree well with the formation temperatures and burial histories estimated for these wells. The subtle contrast in argon loss between these 2 samples suggests that this structure is relatively recent.

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Porosity Evolution and Diagenesis of Smackover Grainstones, Bryan's Mill Area, East Texas

Reservoir carbonates in the Bryan's Mill area of east Texas are ooid-dominated grainstones that occur toward the top of stacked coarsening-upward sequences. Individual grains were coated by isopachous circumgranular cements producing early lithification of the grainstones with retention of a modified intergranular porosity. This was patchily