Part 1: Controls on Architecture of Argentine Limestone & Associated Strata in Northeastern KS & Part 2: A First-Cut Method for Evaluating Limestone Aggregate Durability Using Sepctral Scintillometry

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RESEARCH

Part I

Pennsylvanian strata in the US Midcontinent were deposited in association with high-amplitude glacio-eustatic sea-level fluctuations. Many such sequences are thin and maintain similar thickness throughout wide geographic areas. The facies both build and fill relief. Many of those that fill relief are commonly, but incorrectly ascribed to carbonate mounding. Missourian strata were studied in a 3,670 km^2 area of eastern Kansas to evaluate the controls on build-and-fill architecture.

Nine lithofacies were described in association with the Argentine Limestone, Frisbie Limestone, Quindaro Shale and Liberty Memorial Shale. A sequence stratigraphic framework was established based upon lithofacies distributions and correlations in order to evaluate the controls on lithofacies distributions. Relative changes in sea level controlled the large-scale depositional architecture. Local factors such as accommodation and underlying paleotopography were the most important factors controlling which facies either built or filled depositional topography.

Lowermost strata are those of the Liberty Memorial Shale which created lobate positive topography. Shale facies changed laterally to phylloid algal and possible microbial carbonates, but no mound-like topography was built. A subsequent relative rise in sea level resulted in a condensed section. Phylloid algal and other carbonate facies were deposited after a minor relative fall in sea level. Strata were deposited preferentially in low areas, onlapping preexisting topography. Although these lithologies are typically ascribed to carbonate buildups, geometries clearly filled topography, subduing most of the original paleotopography and resulting in a relatively flat surface. After a minor relative sea level fall, erosion created topography on the upper surface of the Argentine Limestone, which was previously misidentified as the result of mounding.

Results from this study show that the creation of relief in high-frequency glacioeustatic sequences can occur after falls in sea level, with deposition of lobate siliciclastics and erosion of preexisting strata. High or falling sea levels result in carbonate deposits which fill relief and even out topography. Understanding this mechanism of building and filling of relief is paramount to understanding the nature of deposits that are utilized as carbonate aggregate sources. Identifying lithologies that produce good aggregate and understanding how and where they form can help with quality control and aggregate resource exploration.

Part II

There continues to be an increase in demand for durable carbonate aggregate resources for state and regional highway construction projects**.** KDOT has specific protocols for evaluating aggregate durability, but these tests take a minimum of six months to perform necessitating the development of faster, on-the-outcrop first-cut techniques to evaluate the potential durability of an aggregate resource.

Part 2 evaluated the use of a spectral gamma ray scintillometer as a first-cut tool for evaluating limestone aggregate durability. Twenty ledges were sampled in nine stratigraphic units with a spectral gamma-ray scintillometer. Five facies were described based only upon matrix lithology and clay distribution.

A previous KTRAN study determined that the clay content and clay distribution in limestones, as disseminated clay and clay-rich seams, as well as clay minerology, appear to be important factors in the durability of limestone aggregate. Logistic models for determining the probability that an aggregate would pass or fail KDOT physical tests were developed for limestones with micritic matrices. These models were based on the relationship between the maximum measurement of the potassium contribution to the natural gamma radiation (Kmax) and the pass/fail status of a particular KDOT bed. The first model included all of the measurements for a particular KDOT bed. A second logistic model was developed because it is generally believed that shale beds and concentrated stylocumulate zones are removed from the final aggregate product by the crushing process. Therefore, the second model omitted measurements within 30 cm of shale beds and concentrated stylocumulate zones. The first model more accurately predicted the pass/fail status of the aggregate tested suggesting that such clay-rich zone is not removed during crushing.

The type of clays were determined by X-ray diffraction of the clay-sized fraction of acid insoluble residue to test for a correlation between clay mineralogy and whether an aggregate sample would pass or fail the KDOT physical tests. Results showed that the mineralogy of the clays present, and even the number of clays present did not directly correlate with whether an aggregate sample would pass or fail the KDOT physical tests. Instead, it was determined that the amount of clay present, independent of its mineralogy, may be a more important factor. A handbook of instructions for implementation of the first cut test of aggregate durability is provided along with an Excel add-in* that will automatically calculate the probability of an aggregate passing or failing the KDOT physical tests.

Report Information

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*This Microsoft Excel spreadsheet is not available it is in beta testing and will not be included on the CD-ROM

DUE TO FILE SIZE (12 MB) REPORT WILL BE PUBLISHED ON CD-ROM ONLY