occurs. The end product, seen in ancient lithified analogues, is understandably difficult to interpret.

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DIRECTIONAL RELATIONSHIPS BETWEEN PRIMARY STRUCTURES AND CURRENT SYSTEMS IN A TIDE-DOMINATED ENVIRONMENT[1]

Directional current structures occurring in the intertidal zone of the Minas basin at Five Islands, Nova Scotia, include sand waves, megaripples, current ripples, cross-stratification, micro-cross-laminae, scour striae, and flute markings. Their orientation is controlled either by ebb tidal currents or by sheet runoff at low tide. Depth of water, local topographic obstructions, and presence or absence of strong winds exert local influences on the orientation of these directional current structures.

Tidal currents flow at an average velocity of 1.3 knots during flood stage and 1.5 knots at ebb stage. Flood currents flow in an average direction of 60°, whereas ebb currents flow toward an average direction of 255° (readings given in azimuths). Locally, however (such as on the northwestern side of some east-west-oriented islands), ebb currents continue to flow toward the northeast for 2 hours after the shift from the flood to the ebb phase. Such a time lag in shift of flow direction is reflected in the orientation of primary structures. In the northwest lee of these islands, sand waves were observed to be face-oriented toward the northeast. Because sand-wave migration occurs at maximum water depths during the 2 hours before and after the shift from flood to ebb stage, they continue to be face-oriented toward the northeast at the northwest sides of islands. The megaripples and current ripples are formed by ebb tidal currents at lower water depths and are oriented southwestward. In open reaches where change in flow direction coincides with the change from the flood to ebb phase, sand waves as well as superimposed megaripples and current ripples are oriented southwestward.

During the 15 minutes preceding emergence of the intertidal zone, slope-controlled sheet runoff and channel flow in sand-wave troughs dominate the flow systems and form current ripples and flute markings. Their orientation reflects local slope changes. The depth of reworking of such sheet runoff seldom exceeds 1 inch. Consequently, although current ripples formed by sheet runoff may be superimposed on sand waves and megaripples, the internal micro-cross-laminae so produced are, in very few cases, of any consequence in box cores or trenches. Preserved internal cross-stratification, oriented in the same direction as steep faces of sand waves and megaripples, is produced by ebb currents of considerable velocity.

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INTEGRATED METHOD OF FACIES AND RESERVOIR ANALYSIS AS APPLIED TO REDWATER FIELD, ALBERTA

Integration of facies and reservoir analyses presents three main difficulties: (1) the volume of data is huge; (2) few causal relations between petrographic and reservoir properties are known; and (3) geologic data range from quantitative to purely qualitative.

Multivariate statistical methods offer a fruitful approach to the problem. A mathematically derived index allows determination of the similarity between two rock samples by simultaneously considering many environmentally significant variables which may be measured on different scales. A factor analysis of those similar coefficients portrays groups of rock samples that are environmentally distinct (environmental facies).

This same procedure can be used to determine reservoir facies (groups of rock samples with similar reservoir properties). Also, the reservoir properties in each of the environmental facies can be characterized and tested for distinctness. These environmental and reservoir facies must be established before relations between rock properties and reservoir properties can be established. These can be effectively determined by multiple regression and canonical correlation.

This approach was applied to the Redwater field; part of an Upper Devonian reef complex and nine environmental facies were outlined. This gave a detailed picture of reef zonation, from which the mechanics of reef growth could be interpreted. Analysis of the reservoir properties within these facies showed only four reservoir facies.

The study showed that the reservoir properties are controlled primarily by variables sensitive to the original environment of deposition. Porosity-permeability variation also is controlled by properties which reflect the amount and type of diagenesis. Diagenesis, in turn, is shown to be related to original environment.

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DIAGENETIC VERSUS POST-DIAGENETIC DOLOMITIZATION

The kinetics of the reaction, Biogenic carbonate $+ Mg^{++} \rightarrow$ Dolomite $+ Ca^{++}$, have been studied at 300°C. in aqueous solution. Within the dolomite stability field the rate of dolomitization is increased by the following.

a. Increased instability of the reactant.
b. Increased calcium plus magnesium concentration of the dolomitizing solution.
c. Increased magnesium/calcium ratio of the dolomitizing solution.
d. Increased molar solution/solid ratio.
e. Increased temperature.

Each of the above five kinetic variables favors dolomitization in hypersaline environments. However, dolomitization has not yet been precluded in a normal marine environment.

Present carbonate-forming sediments consist predominantly of the metastable minerals aragonite and magnesium calcite. At 300°C. these minerals, compared with calcite, are preferentially dolomitized. In nature, at lower temperatures, similar preferential reaction is observed. In limestone from Bonaire and Jamaica, the magnesium calcite components, in most cases red algae, have been replaced selectively by dolomite. Such preferential dolomitization indicates the penecontemporaneity of the process. The dolomitizing reaction is the mechanism whereby the

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