Radiocarbon-age estimates indicate these impressive piles of coral rubble and sediment have accumulated in the past 9,000 yr (giving a minimum accumulation rate of 1.4 m/1,000 yr) and illustrate the potential for significant carbonate buildups without the need for early lithification.

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Diagenesis and Sea Level Change in a Pleistocene Coral Reef, San Salvador, Bahamas

Near the Cockburn Town reef (dated 125,000 yr B.P.), precisely surveyed bench marks are related to accurately measured mean sea level, and they provide a convenient datum plane. This coral reef developed during a sea level highstand of no more than 10,000 yr, which was insufficient time for significant subsidence; however, subsidence of approximately 3 m may have occurred since the formation of the reef. Sea level changes were caused by fluctuations in glacial-ice volume. The upper beach to dune transition, which is in the calcarenites overlying the reef, is at +4 m. A minimum highstand of +7 m is indicated when corrected for subsidence.

Below +2.5 m, marine aragonite cement occurs within the intragranular pore space of the following: *Halimeda* plates, benthic foraminifera, *Favreina* (Callianassid fecal pellets), gastropods, and corals. Marine aragonite cement also occurs as intergranular isopachous rims on matrix grains of coral rubblestone. Remaining pore space was partly to completely occluded by freshwater vadose calcite cements, which occur without marine cements in the overlying shallow subtidal, beach, and dune calcarenites. No unequivocal freshwater phreatic cements have been found, although syntaxial overgrowths and irregular calcite rims about grains do occur in finer grained sediments where local patches of freshwater saturation occurred within the vadose zone. Later calichification, which affected all facies, is characterized by alveolar texture, whisker calcite, microsparite, rare bladed calcite spar, *Microcodium*, and rhizocretions.

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Hydrogen and Carbon Isotopes of C_1 to C_5 Alkanes in Natural Gases

A technique has been developed to determine C^{12}/C^{13} and D/H isotopic ratios on small quantities of methane through pentane hydrocarbons and has been applied to natural gases from various genetic sources (i.e., early-diagenetic, oil-associated, late-catagenic and mixed-gas sources).

Carbon isotopes measured from 27 natural gases have $\delta^{13}C$ range of 23, 15, and 20‰ for the C_1 to C_3 alkanes and maximum $\delta^{13}C$ values of −35.1, −26.8, and −20.8 ‰ respectively. With a smaller sample base, butane and pentane vary within 16 and 4 ‰, respectively, for those samples with the most positive $\delta^{13}C = -26.5$ and −26.9 ‰.

Deuterium isotopes exhibit greater isotopic variation than the corresponding carbon values. D/H variations clearly decrease toward the higher homologues with δD ranges of 182, 110, 75, 43, and 29 ‰ for C_1 through C_5. Most negative D/H measurements also decrease with carbon number from δD = −311 ‰ for methane to −128 ‰ for pentane.

These relative changes in carbon and hydrogen isotopic contents for the higher homologues are useful in the classification of natural gases, particularly those of mixed origin.

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Sorbed vs. Free Sediment Gases—Differentiation of Thermogenic and Biogenic Gas Sources

The unique phenomenon of hydrocarbon gas sorption on mineral and organic matter surfaces provides the basis of a novel aid for geochemical petroleum exploration. A refined vacuum sediment degassing procedure permits separate analysis of sorbed and free gas fractions. Hydrocarbon gases from both individual fractions can be genetically classified (e.g., diagenetic, thermogenic, catagenic) by their molecular and ^{13}C and ^{2}H isotopic compositions.

In contrast to the normal bulk or free gas fractions, where the composition is frequently influenced by alteration effects such as bacterial gas generation or oxidation, comparative analyses indicate the the sorbed gas fraction can retain its unaltered genetic signature. Exchange between the sorbed and free gas fractions is severely restricted by surface sorption energies and perhaps by structure water, which may assist in the partitioning of gas fractions with different genetic characters. Gas transport within the sorbed fraction is probably a surface-controlled "handshake" diffusion process that minimizes contact with the free gases.

Examples of this phenomenon are provided by Gulf Coast and California surface sediment cores, which display strong biogenic methane formation and oxidation effects in the free gas fraction. In contrast, the corresponding character of the sorbed gas fractions is clearly distinguished as thermogenic and originating in subsurface. Evidence of thermogenic hydrocarbons is obscured during routine bulk analysis by the biogenic free gas component.

This sorption phenomenon has good potential for the identification of subtle geochemical hydrocarbon anomalies previously masked through bulk analysis.

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Burial Diagenesis of Allochthonous Carbonates from a Permian Slope Setting, Southeastern New Mexico

The Bone Spring formation (Permian-Leonardian) from 3-km (9,850-ft) deep conventional cores in the northern Delaware basin is a laminated, black, mixed terrigenous-carbonate mudstone with thin intervals of gray, coarse carbonate-debris flows. All carbonates have been pervasively dolomitized, and porosity and permeability were reduced to 3-8% and 1 md, respectively, during several diagenetic events related to burial history.

Three dolomite generations are defined by fluorescence and cathodoluminescence microscopy and electron microprobe, and are further characterized by means of microsampling for carbon and oxygen isotopes. Over a range of 2 ‰ (PDB), $\delta^{13}C$ decreases steadily from the first to last dolomite generation, reflecting constant mixing of rock carbon and organic carbon as hydrocarbons were evolving in the Bone Spring muds. The first dolomite generation was introduced during the time interval between early postdeposition and burial to approximately 1 km (3,280 ft). Dewatering and compaction of the Bone Spring muds accompanied matrix dolomitization, leaching of metastable grains, fracturing, and silicification of carbonate components. The mean $\delta^{18}O$ of the high-strontium, matrix dolomite is −2.1 ± 0.4 ‰ (PDB). A second dolomite generation may have been late Ochoan; by this time an additional 1.2 km (3,925 ft) of Guadalupian-Ochoan carbonates and evaporites had been deposited. This fluorescent, nearly stoichiometric dolomite cement has a mean $\delta^{18}O$ of −3.0 ± 0.3‰ (PDB), and was coeval with hydrocarbon generation in the Bone Spring. It precipitated from fluids that interacted with the overlying evaporites. Hydrocarbon inclusions are contained in this dolomite, which is succeeded by a generation of anhydrite cement. Sulfur isotopes strongly suggest that remobilized Guadalupian anhydrite-sulfur formed this cement.

The last two diagenetic phases, including the third dolomite generation, crystallized at about present burial depth. Coarsely crystalline, luminescent, pore-filling calcian dolomite, containing hydrocarbon inclusions, has a mean $\delta^{18}O$ of −5.4 ± 0.6 ‰ (PDB). Depleted poikilotopic calcite cement ($\delta^{18}O = -10.3$ ‰, PDB) records the input of Tertiary water.

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Multiple Submarine-Cemented Grainstone Sequences Along Leeward Carbonate Margins: Examples from Late Quaternary of Little and Great Bahama Banks

Coarse-grained, leeward-margin sand shoals, developed during the late Quaternary along the western edges of Little and Great Bahama Bank, have been deposited and preserved in response to regional sediment-transport processes and local physicochemical conditions. These sand bodies are fundamental depositional sequences, chronostratigraphically bounded by subaerial exposure crusts, and thus are of major importance in determining rates of bank-margin growth and in understanding the dynamics of carbonate margin buildup. In the Holocene sediments, these sand bodies are 1-2 km wide, up to 35 m thick, and are present along 400