mineral assemblages, temperature, and fluid compositions. Volumes of fluid necessary to form 5 wt. % of kaolinite are presented as a function of fCO_2 and the above variables.

Formation of kaolinite can be related to hydrocarbon maturation. Decrease in O/C atomic ratios of different types of kerogen during maturation initiates the eventual release of oxygen as CO_2 into the pore fluids. Subsequent precipitation of kaolinite is thus an indicator of hydrocarbon maturation. To quantify this indicator, more research is needed to delineate the controls on the formation of CO_2 during maturation.

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Synsedimentary Tectonic Controls on Facies Evolution of Late Miocene Barrier Reef Complex: Upper Coralline Limestone, Maltese Islands

The central Mediterranean Maltese Islands constitute a local high on the Malta-Ragusa platform, a positive bathymetric feature extending northward to southeastern Sicily. Three main structures are recognizable within the islands and adjacent offshore areas: (1) a prominent north-south structural high through Malta which has been a positive feature since at least the Oligocene; (2) a northwest-southeast fault that has formed the western margin of the islands and controlled facies patterns since the late Miocene; and (3) east-west normal faults of post-Miocene age that form horst and graben structures in north Malta and south Gozo.

The upper Coralline Limestone was deposited in a shallow basin bounded to the east by north-south structure. Evolution of facies patterns with progressive shallowing started with open circulation and deposition of relatively condensed glauconitic grainstones and foraminiferal rudstone shoals. These shoals were then colonized and stabilized by a *Lithophyllum-Thalassia*? association, which on further shallowing was replaced by frame-building coralgal reef and associated facies, or high-energy oolitic and bioclastic grainstones. Terminal stages of deposition are represented by shallow intertidal/supratidal sediments, followed by complete subaerial uplift.

High-energy frame-built and grainstone facies are localized by the northwest-southeast fault. Restricted circulation and shoreline sediments initially formed close to the north-south structure. As basin filling continued, more open-circulation, higher energy facies extended eastward until finally, highest units of the formation are represented 15 km east of the north-south structure. This apparent eastward "transgression" concurrent with shallowing to the west can be explained in terms of regional hinging about the north-south structure. Rotation to the east would allow transgression eastward while simultaneously uplifting western areas.

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Isotope Geochemistry of Calcite and Clay Minerals in Volcanogenic Rocks, Great Valley Sequence, Northern California: Implications for Organic Diagenesis

Petrographic and isotopic data from an 8,500-m thick section of the Great Valley sequence indicate that widespread calcite cement in sandstones and mudstones was precipitated during at least two distinct stages that are linked to organic and clay-mineral diagenesis.

The range of $\delta^{13}C$ values for calcite in mudstone is -11.6 to $+1.0$ ppt PDB, in sandstones is $-9,7$ to $+4.5$ ppt PDB, and in veins is -16.7 to -2.2 ppt PDB. The $\delta^{13}C$ values are heavier in progressively older and, presumably, more deeply buried strata. A strong shift to heavier $^{13}C/^{12}C$ ratios of calcite in mudstones and sandstones corresponds with an abrupt 20 ppt shift to more enriched δD values of OH-hydrogen in diagenetic smectite and a 10A clay-mineral from mudstones. Clay D/H ratios range between -69 to -49 ppt SMOW. The stratigraphic position of the shift corresponds to a modeled burial temperature estimate of about 80 to 100°C. This is interpreted to be the burial temperature for late-stage dehydration and conversion of smectite to a 10A clay-mineral phase.

Theoretical considerations indicate that a shallow burial phase of predominantly pore-filling calcite formed in association with bacterial production of methane (<80°C), or with migrated thermogenic gas. A second stage of calcite, found in deeper strata, and mostly of replacement origin, formed from deep formation waters (>80°C) that contained thermogenically produced low C_2+ gases. Release of dry gas at increasingly elevated temperatures was characterized by continuous ^{13}C-enrichment in CH_4. Depleted calcite carbon in the most basal strata was derived from CH_4-rich basement fluids. Estimation of δD values of formation waters indicates that CH_4-H_2O equilibrium was not attained.

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Oceanographic Controls on Organic Matter in Miocene Monterey Formation, Offshore California

Analyses of the type and amount of organic matter in Tertiary through Quaternary sediments drilled during DSDP Leg 63, off the coast of California, can be used to provide insights into the controls of deposition of the Monterey Shale. The regional oceanography, rather than basin silling, controls the accumulation of organic matter in these sediments. The laminated, siliceous, and organic-rich Monterey Shales were deposited under anoxic conditions within a well-developed oxygen minimum zone like that in today's Gulf of California. The oxygen minimum zone became strongly developed in response to increased upwelling and productivity caused by global cooling following development of an Antarctic ice sheet 13 to 14 m.y. ago. A drop in sea level 10 to 11 m.y. ago lowered the base of the anoxic oxygen minimum zone to water 2,500 to 3,000 m deep permitting substantial accumulation of organic matter in the late Miocene and early Pliocene of the California borderland at DSDP Site 467. The base of the minimum stayed near this level until the Quaternary, then rose to 1,500 to 2,000 m, where it remains today. Phosphorite, indicative of a high rate of supply of nutrients, formed at the same time as the Monterey Shale, during the period of intensive upwelling from 13 to 14 m.y. into the Pliocene. A lessening of upwelling and supply of nutrients, and development of the oxygen minimum zone from the early Pliocene into the Quaternary, is implied by these data. The changes are associated with a warming trend and a rise in sea level.

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Diagenesis and Migration of Hydrocarbons in Monterey Formation, Pismo Syncline, California