

an area can be displayed in a form acceptable and familiar to the experienced geologist. The amount and quality of the displayed information will give the geologist more information, in an objective form, than has ever been available previously. This information, interpreted by the experienced geologist, will result in a higher quality of "decision making" than has been possible previously. Use of a computer will not enable the reduction of an exploration staff, but properly used, will increase the need for experienced geologists and increase the "success ratio."

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DETRITAL DOLOMITE IN ONONDAGA LIMESTONE (MIDDLE DEVONIAN) OF NEW YORK: IMPLICATIONS TO "DOLOMITE QUESTION"

Dolomite occurs in the matrix of the Onondaga Limestone (Middle Devonian) in New York as scattered grains ranging in size from 4 to 150  $\mu$ . Detrital quartz is associated with the dolomite. Study of etched and stained thin sections shows a correlation between grain size of the dolomite and quartz. Limited data show a correlation between grain size of dolomite, quartz, and detrital calcite (silt to fine sand) matrix. In addition there is a correlation between abundance of dolomite and quartz, where high dolomite values occur with high quartz values.

These data suggest that dolomite in the Onondaga is detrital. Source of the dolomite is uncertain, but reworked, pencontemporaneous supratidal sediments and older (for example Silurian) dolomites are possibilities. Wind is a likely mechanism for transport of the detritus.

Deposition of detrital dolomite, followed by later diagenetic overgrowths on the detrital nuclei is suggested as a mechanism for "dolomitization." This process is compatible with the following phenomena observed in dolomitic rocks: (1) association of insoluble detritus with dolomite, (2) occurrence of dolomite in fine-grained limestone, and (3) dolomite interpreted as "primary" (being fine grained) and dolomite interpreted as "replacement" (being coarse grained). Two models for the origin of dolomitic rocks are proposed.

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PALYNOLOGY OF KAIPAROWITS FORMATION, GARFIELD COUNTY, UTAH

The Kaiparowits Formation is the youngest Cretaceous unit in central-southern Utah. One 2,750-ft-thick section of the formation was measured, described, and sampled in the type locality, The Blues, Garfield County, Utah. Palynological documentation is based on the study of 15 samples distributed throughout the formation. Palynomorphs assignable to 80 species in 41 genera were described. One genus and 36 species are believed to be new.

The Kaiparowits Formation is equivalent to the upper Lance or Hell Creek. *Aquilapollenites* spp., *Azolla cretacea* Stanley, and *Proteacidites* spp. proved to be of greatest significance for correlation and dating purposes. Comparisons of the entire flora also indicated that the Kaiparowits Formation is Late Cretaceous.

The lower 2,200 ft of the Kaiparowits Formation was deposited as a delta in a rapidly subsiding basin. The sediments indicate a western provenance—prob-

ably central or western Nevada. The Blues was in the fluvial part of the delta with low, marshy or swampy topography. Uplands and semi-arid to arid areas also were present within the drainage basin. Sedimentation of the upper 550 ft of the formation was probably similar to that of the lower 2,200 ft, but is incompletely understood. Considerable volcanic activity in the region is indicated by the presence of large volumes of bentonitic material within the formation. No evidence was observed to indicate that any of the Kaiparowits Formation in this area was deposited under marine conditions.

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RECOGNITION OF EVAPORITE-CARBONATE SHORELINE SEDIMENTATION

Evaporitic-carbonate shoreline sediments are deposited in an arid or semiarid climate by tidal currents which transport the sediment from the marine environment to the shore. The sediments accumulate primarily as tidal-flat deposits which prograde seaward producing a vertical sedimentary sequence from marine to supratidal. The supratidal sediments are the most easily recognized. They are characterized by irregular laminations, desiccation features, lithoclasts, and a general lack of fossil material. The intertidal sediments are more difficult to identify. They commonly are pelleted carbonate mud with burrows and a restricted fossil assemblage. Gastropods are dominant in many places. The vertical sedimentary sequence is the most useful tool to identify intertidal sediments. The sediments just below the supratidal are generally intertidal sediments.

The arid or semiarid climate allows seawater to evaporate and become saturated with respect to gypsum or anhydrite when the water circulation is sufficiently restricted from the open ocean. Primary bedded gypsum is precipitated in shallow lakes in the tidal-flat environment. In order for gypsum to be deposited in lagoons connected to the open sea by a channel, the ratio of the surface area of the lagoon to the cross sectional area of the channel must be about 10<sup>6</sup>. Most gypsum or anhydrite associated with shoreline sediments is present as nodular, replacement, or pore-filling crystals. This type of evaporite is secondary and crystallized from hypersaline interstitial water. The hypersaline interstitial water is the result of evaporation at the sediment-air interface. Bedded gypsum or anhydrite, then, indicates the existence of a hypersaline lake or lagoon environment whereas nodular, replacement, or pore-filling gypsum or anhydrite is secondary and is found in marine, intertidal, and supratidal sediments.

The precipitation of gypsum or anhydrite from seawater produces a dolomitizing fluid according to the reflux dolomitization theory. This type of dolomitization starts in the supratidal sediments and spreads into the underlying sediments. Therefore, extensive dolomitization associated with tidal-flat sedimentation indicates evaporitic shoreline sedimentation.

Evaporites are removed easily by shallow groundwater. They are not well preserved in outcrops, and most commonly they are absent. Comparisons of subsurface anhydrite and outcropping shoreline sediments show that, in many places, the anhydrite or gypsum has been leached from the outcrop samples leaving molds and in places producing solution collapse breccias. Calcification of anhydrite or gypsum and dolomite is common. The recognition of evaporitic shoreline sedimentation from outcrop samples commonly makes it necessary to establish whether dissolution of evaporites