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Morphologies of Gypsum on a Modern Sabkha: Clues to Depositional Conditions

Gypsum is the dominant evaporite mineral across the Holocene marine sabkha of the northwest Gulf of California, Baja California, Mexico. This sabkha is a complex of mud flats and saline pans in which gypsum occurs as layers and isolated intrasediment crystals. Six distinct morphologies of gypsum were found: flat plates, acicular prisms, bladed prisms, blocky prisms, blocky hemipyramids, discoidal hemipyramids. *Flat plates* (< 0.5 mm wide) and *acicular prisms* (< 1 mm long), in the form of radiating clusters and interpenetrating twins, crystallize at the brine-air interface during the temporary saline lake stage of the pan. These tiny crystals settle out on the bottom of the pan as a cumulate layer. *Bladed prisms* (0.5-1.5 mm long) nucleate on this cumulate layer and grow upward as vertically oriented prisms (commonly swallowtail twins) making a "grass-like" layer. *Blocky prisms* (up to 2 cm long), barrel-like in shape with swallowtail twin terminations, are found as pendant cements in shelter vugs formed by buckling of the gypsum layers of the pan. *Blocky hemipyramids* (up to 1 cm across) are found as a loose mush making a diapir-like mound beneath m-scale polygonal cracks in the layered gypsum of the pan. These clear. blocky hemipyramids grow diagenetically in the vadose zone during the dry stage of the pan when evaporative pumping draws subsurface brine up along the polygonal cracks. *Discoidal hemipyramids* (up to 2 cm long) occur as isolated crystals. clusters of crystals, and rosettes within the siliciclastic sediment of the mud flats surrounding the pan. They are of vadose and phreatic origin.

Gypsum morphologies clearly vary with depositional conditions across this sabkha and this finding should allow us to use morphological variation in gypsum as a sensitive interpretative tool for ancient evaporites and evaporitive sediments.

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Anatomy of a Modern Marine Sabkha in a Rift Valley Setting, Northwest Gulf of California, Baja California, Mexico

An extensive sabkha, 100 by 20 km (62 by 12 mi), caps Holocene siliciclastic tidal flats along the coast of Baja California in the northwest Gulf of California structural trough. This sabkha, bounded on the west by alluvial fans, is a complex of sand flat, saline mud flat, gypsum-halite pan, and supratidal mud flat subenvironments. The sand flat, transitional between the fans and the sabkha, consists of horizontally to wavy laminated sand washed onto the flats by sheetfloods from the fans under upper-flow-regime conditions. The sand flat passes into saline mud flats characterized by massive mud crowded with discoidal gypsum crystals grown within the sediment, destroying the layering. This intrasediment growth of gypsum is driven by evaporative pumping of brine from a shallow subsurface brine body. A gypsum pan occupies a wide, shallow depression within the saline mud flat. After storm flooding (either marine or meteoric) the pan becomes a temporary saline lake with an algal mat overgrowing a siliciclastic storm layer. Precipitation of gypsum needles from the open lake brine and bottom growth of gypsum prisms produce a gypsum layer that mimics the algal mat topography. Evaporation of the lake leads to (1) vadose diagenetic growth of gypsum that distorts and polygonally disrupts the gypsum layers (2) deposition of a surface halite layer in the center of the pan. These layered pan deposits are the evaporites of the sabkha. Seaward of the saline mud flats are supratidal mud flats underlain by millimeter-thick laminites with deep prism cracks, sheet cracks, and scattered gypsum discoid crystals. Pervasive mud cracking during long periods of nondeposition completely disrupts layering, creating a massive arid "soil." A beach ridge separates this sabkha complex from the burrowed and ripple cross-laminated intertidal sediments.

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Strike-Slip-Influenced Sedimentation in Norfolk Basin, Southeastern Massachusetts

Pennsylvanian coarse-grained fluvial sedimentation in the Norfolk basin of southeastern Massachusetts occurred in a tectonically active environment, possible related to sinistral strike-slip motion on faults west of the basin. Detailed measured sections reveal an overall upward-fining succession, with humid alluvial fan facies and braided stream sub-facies with associated overbank/flood-plain deposits. The humid alluvial fan contains massive bedded, clast supported conglomerates with infiltrated sandstone and siltstone. Fluvial dominance during deposition is indicated by frequent upward-fining cycles, lack of evidence of debris flow, and clast rounding and imbrication.

The braided stream sub-facies is distinguished by a reduction in bed thickness and clast size (maximum clast size = 5 cm), and commonly contains upward-fining cycles. Although trough cross-bedding angles are low throughout the basin, low angle (< 10°) troughs upslope grade into distal very low angle (< 5°) troughs to plane beds, indicating lesser channel incision and greater sheetflood conditions downslope. The overbank/flood-plain deposits include plane laminated siltstone and claystone with common desiccation cracks.

Evidence for active faulting during deposition includes: mismatch of detrital grain mineralogy with adjacent source terrains; soft sediment boudinage; mixtures of fresh and altered feldspar; and rapid lateral and vertical facies changes.

Provenance studies suggest a source area for many of the sediments might be metabasalts and marbles of the Blackstone Series of northern Rhode Island. If correct, these results support paleomagnetic and other regional studies suggesting sinistral strike-slip motion may have formed the Carboniferous basins of Massachusetts and Rhode Island.

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Preliminary Study of Palynomorphs and Other Plant Fossils from Mississippian Clastic Sediments, Antler Basin, Nevada and Utah

A preliminary study of palynomorphs and other plant fossils from Mississippian clastic sediments in the Antler basin, Nevada and Utah, suggests that much of the Upper Mississippian sediments were deposited in a transitional environment rather than a marine environment, as previously thought. The Antler basin received most of its clastic sediments from the east flank of the north-south-trending Antler orogenic belt in central Nevada. The clastic sediments generally become finer and thinner eastward until they interfinger with a carbonate platform in central Utah.

Numerous fossil plant taxa have been found in these clastic sediments from central Nevada to central Utah. Assemblages of terrestrial palynomorphs associated with lycopod bark impressions (*Lepidodendron*), leaf impressions (*Lepidophyllum*), fruiting body impressions (*Lepidocarpon*), and, most importantly, impressions and casts of rootlike rhizomes (*Stigmaria*) suggest that the plants grew in place during periods of nonmarine deposition.

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Eocene Wave-Dominated Deltaic Sedimentation, Oregon Coast Range

The Eocene Tyee and Coaledo Formations of southwest Oregon together illustrate vertical and lateral facies changes in delta-front and prodelta-to-shelf deposits, which prograded into a forearc basin. Prevalent coarse sandstone bodies with wood also contain large-scale, contorted cross-bedding; they show north-northwest paleocurrent transport directions. An abundance of hummocky stratification and symmetrical ripples in the prodelta and shelf sandstones indicate the dominance of wavy processes.

Conglomeratic, coaly, cross-bedded coarse sandstone, hummocky-bedded, and siltstone-mudstone facies are distinguishable in the Eocene strata. These five well-defined facies are interpreted to represent fluviodeltaic, marsh-swamp, delta-front distributary, prodelta, and shelf deposits, respectively. Burrowed medium sandstone and shelly coarse sandstone facies in the Coaledo Formation are inferred to represent delta-margin deposits. Delta-front and prodelta deposits show soft-sediment deformation features, which indicate rapid deposition during erratic episodes of river flooding. Hummocky cross-stratification and burrowed beds with truncated tops indicate episodic storm events in the prodelta and shelf deposits.