outlines of the former sulfate crystals; (6) relict inclusions of anhydrite, barite, or celestite; (7) enterolithic folds; (8) various kinds of chert, including length-slow chalcedony; (9) saddle-shaped dolomite crystals; (10) dedolomite; and (11) fluorite. The Dorag model was developed from study of the classical mid-Ordovician authigenic feldspar-bearing strata, where hypersalinity must have prevailed.

Research in modern sea-marginal pools of the Red Sea shows that dolomite forms only where gypsum and/or anhydrite is likewise present. Among submerged algal mats where gypsum is absent, the carbonate minerals are aragonite or high-magnesian calcite; by contrast, where gypsum is abundant in deeper parts of pools, or among submerged algal mats, dolomite is present. Likewise, in a pool-marginal salina, not only halite, gypsum, and anhydrite, but also dolomite, form a cement between constituent particles. The high salinities at which gypsum precipitates (up to 330×10^3 mg/L in the summer) and the observation that dolomite prefers sulfate association suggest that both minerals owe their origin to hypersaline brines.

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Distribution of Carbonate Cements in Quarternary Alluvial-Fan Deposits, Birch Creek Valley, East-Central Idaho—Diagenetic Model

Quaternary alluvial-fan deposits in Birch Creek Valley are poorly sorted carbonate gravels that have undergone diagenesis in the meteoric realm through the dissolution and precipitation of calcium carbonate. Three diagenetic zones are documented on the basis of cement morphologies and paragenesis: (1) near-surface vadose, (2) vadose, and (3) "vadose-phreatic."

Cements formed in the near-surface vadose zone result from both pedogenic and nonpedogenic processes. Pedogenic processes predominate within the upper meter of fan surfaces, whereas nonpedogenic processes cause case-hardening on steep, unvegetated outcrops. Pedogenic cementation proceeds in a series of four morphologic stages and is characterized by clotted micrite and fibrous sparry calcite, commonly with gravitational morphologies and intricate banding. Nonpedogenic cements are primarily micritic to finely crystalline with homogeneous or clotted textures; microdigitate cements are common on the undersides of clasts.

Dissolution and incipient cementation are typical in the vadose zone; cements are best developed beneath large clasts. Thin, banded, gravitational cement, grain-contact cement, rare syntaxial overgrowths, and the lack of clotted micrite are indicative of vadose cementation.

Well-cemented fanglomerate reflects progressive cementation in the "vadose-phreatic" zone, or in a zone of water-table fluctuation. Two generations of cement are generally apparent. Early micrite cement forms discontinuous to continuous rims and is followed by an isopachous sparry cement. Syntaxial overgrowths are relatively common on monocrystalline grains. The degree of cementation is variable and appears to be related to grain size, sorting, and packing geometries.

The distribution and nature of the cements suggest that cementation is initiated soon after deposition and proceeds simultaneously in each diagenetic zone.

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Computer-Assisted Structural Analysis

The structural geologist's conceptual interpretations must be in accord with available data and in geometric balance. Traditionally, he has manually generated cross sections (two-dimensional) and maps (three-dimensional). From these models, iterative measurements of line lengths, areas, and volumes provide boundary conditions for a most logical solution. Projection and display from one domain to the other can involve tedious and error-prone work in the transformation of data elements.

Computer HELPWARE, defined as "the sum total of hardware, software, data management and, most important, peopleware," can assist the geologist in the search for a "most reasonable" interpretation.

Data management, with standardized definitions, is an essential element in automatic generation of maps from cross sections and vice versa. Three fundamental types should suffice; line, random, and grid formats each with linkage to a header record describing the subset attributes.

Input user-options include dynamically changing "L-Axis" projections of plunge and azimuth. The "L-Axis" interpretations may be determined from statistical curvature analysis techniques (SCAT) of dip-vector data.

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Land-Surface Subsidence in Houston-Galveston Region, Texas

The pumping of large amounts of groundwater in the Houston-Galveston region, Texas, has resulted in water-level declines between 1943 and 1973 of as much as 61 m in wells completed in the Chicot aquifer and as much as 99 m in wells completed in the Evangeline aquifer. The maximum average annual rates of decline for those years were 2.0 m in the Chicot aquifer and 3.3 m in the Evangeline aquifer. From 1964 to 1973, the maximum average annual rates of decline were 3.0 m in the Chicot and 5.4 m in the Evangeline. The declines in artesian pressures have resulted in pronounced regional subsidence of the land surface.

The center of subsidence in the Houston-Galveston region is at Pasadena, Texas, where as much as 2.3 m of subsidence occurred between 1943 and 1973. More than 0.3 m of subsidence occurred at Pasadena between 1906 and 1943. The maximum amount of subsidence during 1964-73 was about 1.1 m.

In the southern part of Harris County, about 55% of the subsidence is a result of compaction in the Chicot aquifer. The area in which subsidence is 0.3 m or more has increased from about 906 sq km in 1954 to about 6,475 sq km in 1973. The annual cost of damage attributed to subsidence for 1969-74 was estimated, in a study by Texas A&M University, to be about $32,000,000 in 2,448 sq km of the area most affected by subsidence.

The pumping rate has been almost stable since 1967, and the rate of decline in water levels has decreased significantly. The rate of subsidence has decreased since September 1976. As a result of increased use of surface water, groundwater production decreased about 303 million L/day and groundwater levels rose as much as 18 m in the central part of the region in 1977. Because of the pressure recovery, the rate of subsidence should decrease substantially in some critical areas.

The Harris-Galveston Coastal Subsidence District was created by the Texas Legislature in 1975 to cope with the problem of land-surface subsidence. The District plans to control subsidence by controlling and regulating groundwater pumping.

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Dolomitization—Recent Experimental Approaches

Experimental studies of the kinetics of reaction of calcium carbonate with magnesium-calcium chloride solutions indicate a solution-reprecipitation mechanism with a cation-ordered protodolomite as the initial reaction product. Nucleation of ordered dolomite is extremely difficult at low temperatures and is an important factor in the reaction. The kinetics of the reaction are strongly dependent on temperature and on the reactant (calcite or aragonite). Experimental dolomitization of aragonite at 100°C and atmospheric pressure has permitted study of the reaction under conditions approaching those of natural sedimentary environments. These studies indicate that other important kinetic factors include the ionic concentration (salinity), the Mg^{++}:Ca^{++} ratio in the dolomitizing fluids, and the presence of strongly hydrated ions. Certain amino acids and soluble proteins severely inhibit the reaction, but may be removed by oxidation. The results of these experiments may aid in the interpretation of the processes involved in sedimentary dolomitization.

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Oakville Formation of Texas Coastal Plain—Depositional Systems, Composition, Structure, Geohydrology, and Uranium Mineralization

The Oakville Formation consists of deposits of a bedload fluvial system composed of at least four major and several minor rivers that flowed across the Miocene Texas coastal plain. Rivers of the southwestern part of the system transported polymictic sand and gravel containing abundant volcanic clasts; stream deposits of the northeastern area are uniquely rich in reworked carbonate-rock fragments. Structures suggest highly variable to ephemeral flow and extensive development of crevasse splays. Bounding flood-plain muds consist of kaolinitic calcium to sodium montmorillonite. Illite is present locally.

Hydrogeology and uranium mineralization are strongly influenced by a broad belt of subjacent Wilcox (Eocene age) growth faults. Mineralization and alteration patterns reflect the complex flow of groundwater within a stratigraphically and structurally compartmentalized aquifer. With evolution of the Oakville aquifer system, faults have acted both as flow boundaries and as loci for intrusion of deep-seated highly reducing brines and shallow meteoric groundwater, further obscuring primary ore-forming processes. Volcanic glass within and possibly above the Oakville provides a probable source for the uranium.

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A New Look at Geology of Togo By SLAR

Imaging of Togo, West Africa, with Side-Looking Airborne Radar (SLAR) in 1977 provided the data required for the production of semicontrolled radar mosaics at a scale of 1:200,000. These mosaics revealed significant errors in the existing geologic and topographic maps of Togo. The mosaics also served as a base for the generation of a new geologic map of Togo. The use of two opposing radar "look" directions helped in making numerous revisions, such as identifying previously unknown structural features, age relationships, refinement of unit boundaries, and the repositioning of structural features and lithologic units. Positional errors in some cases involved relocation of points by as much as 12 km and reorientation of major faults by as much as 22°. Although the value of radar's synoptic view and low illumination angle for detecting geologic features has been clearly demonstrated, the utilization of a SLAR mosaic for rectifying the location and orientation of geologic features has not received sufficient attention.

Geologic mapping of Togo was initiated as early as 1905, and sporadic but continuing revisions occurred through 1973. The fact that numerous investigators with diverse interests have participated in subsequent mapping, without apparent rectification of major errors in position and orientation, suggests that errors on earlier maps were incorporated into more recent versions. That this is the case is emphasized by the lack of congruence of major, topographically expressed rock units and structures in recently published, small-scale maps with their well-defined counterparts on the radar mosaics. Furthermore, it suggests the seriousness of the error of geologic-map revision utilizing a previously published map as a base without verification of its geometric fidelity.

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Probing Bermuda's Lagoons and Reefs

Preliminary seismic reflection profiling of Bermuda's lagoons, using the Uniboom system, followed by reconnaissance drilling, has shown that the lowest horizon on the seismic profiles is a strongly reflecting layer, almost horizontal, and with surface roughness of 1 to 3 m. It lies at a depth of about 19 m below sea level near the center of the platform and slopes very gently to 32 m beneath the rim. It appears to be the foundation upon which the rim, reefs, and lagoons have developed, culminating in the present configuration.

Above this surface there are Pleistocene reefs, thick