outlines of the former sulfate crystals; (6) relict inclu-
sions 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 al-
gal mats where gypsum is absent, the carbonate miner-
als 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. Like-
wise, in a pool-marginal salina, not only halite, gypsum,
and anhydrite, but also dolomite, form a cement be-
tween constituent particles. The high salinities at which
gypsum precipitates (up to $330 \times 10^3$ mg/L in the sum-
mer) and the observation that dolomite prefers sulfate
association suggest that both minerals owe their origin
to hypersaline brines.

FUNK, JAMES M., Shell Oil Co., Houston, Tex.

Distribution of Carbonate Cements in Quaternary Al-
luvial-Fan Deposits, Birch Creek Valley, East-Central
Idaho—Diagenetic Model

Quaternary alluvial-fan deposits in Birch Creek Val-
ley are poorly sorted carbonate gravels that have under-
gone diagenesis in the meteoric realm through the disso-
lution 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 re-
sult from both pedogenic and nonpedogenic processes.
Pedogenic processes predominate within the upper met-
er of fan surfaces, whereas nonpedogenic processes
cause case-hardening on steep, unvegetated outcrops.
Pedogenic cementation proceeds in a series of four mor-
phologic stages and is characterized by clotted micrite
and fibrous sparry calcite, commonly with gravitational
morphologies and intricate banding. Nonpedogenic ce-
mements are primarily micritic to finely crystalline with
homogeneous or clotted textures; microdeterminate 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 cementa-
tion.

Well-cemented fanglomerate reflects progressive ce-
mation in the "vadose-phreatic" zone, or in a zone of
water-table fluctuation. Two generations of cement are
generally apparent. Early micrite cement forms discon-
tinuous to continuous rims and is followed by an iso-
pachous sparry cement. Syntaxial overgrowths are rela-
tively 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.

FUSSO, JOSEPH W., JR., Chevron U.S.A. Inc., San
Francisco, Calif.

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-dimension-
al). From these models, iterative measurements of line
lengths, areas, and volumes provide boundary condi-
tions 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 ele-
mments.

Computer HELPWARE, defined as "the sum total of
hardware, software, data management and, most impor-
tant, 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 sub-
et set attributes.

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


Land-Surface Subsidence in Houston-Galveston Re-

gion, Texas

The pumping of large amounts of groundwater in the
Houston-Galveston region, Texas, has resulted in wa-
ter-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 attrib-
uted 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,