Pit, confirming missing section and illustrating how this iridium layer is proving useful as a worldwide time marker.

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Relationship of Morphologic Variation and Environment in Recent *Bolivina* (Foraminiferida) from Northwestern Gulf of Mexico

This study investigates intraspecific morphological variation trends of recent benthic foraminifera in relation to depth and environmental factors (temperature and salinity). Twelve samples were obtained from traverses trending south-southeast from offshore Galveston, Texas, to the Sigsbee Deep. Samples are cuts of short cores (30-40 cm, 12-16 in.) from 33-3,431 m (108-11,257 ft) in depth. Fifty specimens from the total population (all growth stages) and 30 specimens of a specific growth stage were randomly selected for each of 4 foraminifera species, *Bolivina albatrossi, B. lowmani, B. subspinescens,* and *B. ordinaria,* from each sample site. Test outline, as an indicator of overall shape, was quantified by an automated video digitizer using closed-form Fourier series analyses. Significant variations in shape outline components were tested for their relationships to bathymetry and environmental factors using analysis of variance and multiple discriminant analysis for both total populations and the specific growth stage.

Morphologic trends relatable to both depth and environmental variables are recognizable in the 2 data sets. Such trends may be observable in the fossil record, thus indicating relative depths and suggesting possible absolute depth and values of environmental variables. This morphologic approach may be utilized even though different species are incorporated in analyses and different absolute depths involved.

GASSAWAY, GARY S., Terra Linda Group, Inc., San Rafael, CA, and H. J. RICHGELS, Marjac Geo Inc., Franktown, CO

SAMPLE—Seismic Amplitude Measurement for Primary Lithology Estimation

SAMPLE is a method of seismic interpretation that extracts shear wave velocities or Poisson's ratios from the seldom used amplitude variations within a common-depth-point (CDP) gather. From a crossplot of pressure wave velocity and Poisson's ratio, lithologies and pore fluids are then estimated.

The SAMPLE method works because reflection and transmission of elastic waves (seismic waves) at the boundary between two media are a function of 6 parameters. Three elastic parameters in each media are P-wave velocity, Poisson's ratio or *S*-wave velocity, and density. Given these 6 parameters and the angle of incidence of a plane elastic wave, the reflection and transmission amplitudes (coefficients) can be calculated using Zoeppritz's equations. SAMPLE is an inversion of this calculation. *P*-wave velocity is determined in a conventional manner (i.e., Dix interval velocities). Density is assumed to be a function of *P*-wave velocity. The unknown Poisson's ratios can be determined from the reflection amplitude variation with angle of incidence (offset versus amplitude variations within a CDP gather.)

Having solved for *P*-wave velocities and Poisson's ratios, lithologies and fluids are estimated.

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Landsat Maps of Iraq: Tools for Non-Invasive Exploration

Optical analysis of Landsat imagery is a valuable preliminary step for exploration in areas where a detailed geologic base is lacking, logistics are difficult, or the political situation is insecure. Two maps of Iraq produced by such analysis elucidate structural and lithologic relations across a broad oil-producing region. The Landsat map of Iraq is divided into units based on drainage patterns, surface textures, relative resistance to erosion, and color. These units tentatively correlate to the broadly generalized geologic map of Iraq. The Landsat map clearly delineates Iraq's 3 major geotectonic zones: (1) desert and alluvial plains, (2) simply folded, and (3) overthrust. The lineament and anomaly map, derived from optically enhanced imagery, shows noncultural lineaments and 5 types of anomalies: (1) linear, (2) circular, (3) structural, (4) textural, and (5) shade. Conjugate shear sets form lineaments oblique to the regional and local compression directions. Lineaments also reflect normal faults, tear faults, thrust fronts, structural control of wadis, and wind-direction features. The intersection of 3 or more lineaments defines a linear anomaly. Circular anomalies can be attributed to structural domes or basins, diapirs, calderas, or astroblemes. Appreciable deviations from local deformational style are considered structural anomalies. Textural anomalies are abrupt changes in texture unrelated to lithologic changes. Shade anomalies, mapped from band 5 enhancements, reflect a shade change from light to dark, usually across a lineament. Comparison of oil field locations to Landsat-mapped units, lineaments, and anomalies can indicate exploration targets for more detailed ground-based geologic and seismic investigation.

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A Shallow Water Eocene Turbidite Sequence From Venezuelan Andes

Part of the Eocene sequence in Trujillo State, overlying the sublittoral marine Valle Hondo Formation, reveals a turbiditic mode of origin in a prodeltaic setting. The exposed basal fining- and coarsening-upward cycle implies a gradual abandonment phase and a subsequent progradational pulse of a suprafan channel respectively. The upper unit, in a separate exposure, is a thick coarsening-upward sequence of deltaic progradation origin.

The fining-upward (and thinning-upward) sequence, resting on a prodeltaic shale, consists of: (a) basal stacked conglomeratic arenites (suprafan channel) with graded beds, imbricate clasts and transported shells; (b) a sandy/shale unit (channel margin/inter-channel) with flame structure, lenticular bedding, infrequent $T_{b\text{-}d}$ sequence, rippled flats, and rare *Planolites*; and (c) a dark shale (prodelta-platform) with scarce *Chondrite* and *Sclarituba* (?) traces. The overlying coarsening-upward sequence consists of thickening-upward sandy/shaly facies and lenticular stacked pebbly arenites.

The upper unit is a typical deltaic progradational sequence with a basal prodelta shale with $T_{b\text{-}d}$ and $T_{b\text{-}e}$ sequences in thin intercalated sandstones; a delta-front heterolithic facies with flute and groove casts, *Planolites/Thalassinoides*; and a thick cross-stratified coastal marine sandstone.

Considerations such as maturity of the turbiditic arenite, its inferred proximity to the paleoshoreline, and facies relationship with the Valle Hondo deposits suggest deposition at the toe of delta-front slopes and seaward. It is likely that this flyschoid sequence may be part of a mixed-type fan as it merges northward and basinward into the deep-sea fan sequence of the coeval Trujillo Formation.

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Pteridinium: An Element of Late Precambrian Ediacaran Fauna from Carolina Slate Belt, Southern Appalachian Orogen

Discovery of oil and gas in the western overthrust belt has spurred renewed efforts in the southwestern and eastern overthrust belts. Reinterpretations of existing data and acquisition of new data, both geologic and geophysical, have led to several interpretations of the sedimentary history and overthrust geometry of these belts.

Although the Carolina Slate belt (CSB) is not a prime petroleum exploration target, the documentation of metazoan elements belonging to the late Precambrian Ediacaran fauna in the CSB is new data pertinent to interpretations of sedimentary history and accretion geometry of an exotic terrane that by some interpretations may be involved in overthrusting and is thus concealing potentially petroleum-bearing strata. The presence of *Pteridinium* in the CSB provides correlation with late Precambrian strata of the Russian platform, South West Africa, and South Australia, and is thus very significant in paleogeographic reconstructions.

Pteridinium in the CSB is represented by 4 specimens that are impressions of "petal-like" metazoans. These metazoans are approximately bilaterally symmetrical, crudely ovoid-shaped, and composed of curved segments that join across a medial zig-zag groove created by the proximal