islands' six active volcanoes over the past 36 years. This Galapagos volcanic production rate estimate is used to calculate the contribution of Galapagos volcanism to global volcanic activity and allows comparison to the production rates of other active volcanic fields. In addition, a detailed account of the location and extent of 15 incompletely documented volcanic events has been established.

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Petrology and Stratigraphy of Triassic(?) "Nazas Formation," Sierra de San Julian, Zacatecas, Mexico

The Triassic(?) "Nazas Formation" of north-central Mexico is a sequence of volcanic flows, pyroclastic rocks, and volcaniclastic sediments. Outcrops occur in the Sierra del Rosario del Teyra, Guadalupe, and San Julian of northern Zacatecas. The Nazas is overlain unconformably by the Zuloaga Formation of Oxfordian age (Late Jurassic). A radiometric date of 230 ± 20 m.y. has been obtained for the Nazas volcanic rocks in the Villa Juarez uplift. Thus the Nazas Formation is tentatively correlated with the Huizachal Group of northeastern Mexico, the Eagle Mills Formation of the U.S. Gulf coastal province, and the Newark Supergroup of the Appalachian and Atlantic coastal provinces.

In the Sierra de San Julian, the sedimentary units of the Nazas include: (1) non-stratified, clayey matrix-supported pebble conglomerates; (2) planar-bedded and low-angle planar cross-stratified sandstones with interbedded siltstones; and (3) varved siltstones. A sequence of graded, sandy matrix-supported cobble-boulder conglomerates forms the uppermost unit in the Nazas.

Petrographic studies in progress suggest the following: (1) silicic-intermediate ashflow and airfall tuffs are volumetrically predominant; (2) sediments were derived mainly from the penecontemporaneous volcanic rocks, with a minor metamorphic source indicated by the presence of sand-size, finely polycrystalline quartz grains; and (3) the entire formation has had a complex diagenetic history. Hematite, calcite, and sericite are abundant alteration products.

BOLLA, WILLIAM OWEN, Wright State Univ., Dayton, OH

Gravity Investigation of Suspected Silurian Reef in North-Central Ohio

In his 1873 report on Wyandot County, Winchell discusses two unusual exposures of the Niagaran limestone near Carey, Ohio. These were designated as the "North Ridge" and the "West Ridge." Further work by Cumings and Shrock, published in 1928, led to the identification of these ridges as klintar of Silurian age. An active quarrying operation on the North Ridge supplies ample evidence of its origin. The Wyandot Dolomite quarry has uncovered a Silurian reef, exposing parts of the core mass, flank beds, and cap rock. In looking at the West Ridge, any conclusive evidence which once existed has been lost with the filling of abandoned quarries. The purpose of this report is to delineate the suspected reef in the West Ridge by its gravity anomaly.

Density determinations performed on samples taken from the North Ridge indicate a small density variation among the facies. Considering this factor, the station spacing was set at 200 ft (61 m) to insure detection of the anomaly. The gravity residual was calculated by least squares analysis on an IMB 370 computer. In this method a mathematical surface is calculated using the Bouguer value. This mathematical surface is fitted to the Bouguer surface and subtracted leaving the residual anomaly as the remainder. Since this system uses a point-to-point analysis, small variations in the residual anomaly should be readily detected. Two lines of these data have been selected for additional analysis by modeling using Talwani's two dimensional approach.

The shape of the residual anomaly and the fit between the theoretical profiles and the field profiles, together with the abrupt thickening of the Niagaran section as seen on electric logs, indicate that the West Ridge is a topographic expression of a Silurian reef.

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Subsurface Geology of Bayou Jean La Croix Field, Terrebonne Parish, Louisiana

Bayou Jean La Croix is on an east-west oriented domal feature located approximately 45 mi (73 km) south-southwest of New Orleans. Through June 1980, it has produced 6,490,630 bbl of oil, 1,368,000 bbl of condensate, and 49.6 Bcf of gas. The producing interval extends from the *Cibicides carstensi* to the *Robulus* 5 zones (upper middle Miocene).

The origin of the structure is probably related to deep-seated salt movement. Simple closure is interrupted by numerous east-west down-to-the-south faults crossing the structure. Dip on the major faults averages 48° and throw increases slightly through the productive section. All known oil and gas reserves are found upthrown to these faults.

The productive section is a deltaic-marine sand and shale sequence typical of the south Louisiana Tertiary. By obtaining expansion indices for correlative units in the stratigraphic section enveloping the structure it is possible to graphically plot structural movement. This analysis indicates that the maximum movement occurred between *Cibicides carstensi* and *Uvigerina* 3 times. This correlates closely with the time of accumulation of the majority of the hydrocarbons in the field. Further stratigraphic study will be undertaken to determine why the field's moderate reserves are only trapped upthrown to the faulting.

COYLE, DOUGLAS ROBERT, Texas A&M Univ., College Station, TX

Depositional Environment and Reservoir Characteristics of Lower Cretaceous Paluxy Sandstones, Bolton Field, Hinds County, Mississippi

Bolton field produces oil from numerous lenticular, Lower Cretaceous sandstones at depths ranging from 8,350 to 11,800 ft (2,545 to 3,596 m). The field is on an elongated, faulted anticline in the northwest part of the Mississippi salt basin. It was discovered in 1954 as a result of seismic mapping. Two years after its discovery it had produced 1,475,179 bbl of oil. A core of the Lower Cretaceous Paluxy sandstone, and electric logs from the field area, were studied to determine the environment of deposition and reservoir morphology.

The Paluxy sandstones were deposited within a fluvial system. Primary rock properties observed in the core indicate a braided stream deposit. Bedsets are thin, ranging from 0.5 to 9 ft (.15 to 2.74 m) in thickness. Sedimentary structures within bedsets consist of inclined laminae in the lower part to parallel laminae and ripples in the upper part, indicating deposition

from decreasing flow regime. This sequence of bedding, together with the vertical decrease in grain size observed, is typical of a fluvial sandstone. Sandstones (quartzarenite) are characterized by a high quartz content (85 to 98%), moderate matrix (5 to 10%), and a small amount of minor constiuents (muscovite and calcite).

Electric log cross sections reveal lateral variation in sandstone thicknesses. Sand bodies are lenticular and discontinuous, characteristic of intermittant braided stream deposition. Reservoir sandstones have porosities ranging from 12 to 22% and permeabilities of up to 500 md. Recognition of the vertical sequence of primary rock properties is indicative of braided stream deposits, and the associated electric log characteristics may aid in future exploration and production efforts for similar reservoirs.

GRANDER, H. KIRK, Univ. Maryland, College Park, MD

Geomorphic Controls on Course of Juniata River in Valley and Ridge Province, Pennsylvania

Structural and lithologic factors affect stream-flow patterns of the Juniata River, a cross-axial superimposed consequent stream, in the Valley and Ridge province of Pennsylvania. From an examination of the influence of folding, faulting, and jointing upon the course of this stream and its major tributaries through a succession of points and reaches, the various means have been identified by which its course is determined across both weak and resistant rock deformed into a variety of geometric attitudes. Jointing, thrust faulting, normal and reverse faulting, superimposition, subsequent stream development, and monoclinal shifting in the classic sense of Gilbert are the geomorphic controls. No one control is dominant, all being effective, owing to the complexity of the jointing, folding, and faulting of the region. Monoclinal shifting will probably dominate as the principal geomorphic control in the geologic future.

HELLMANN, ROLAND, Univ. Maryland, College Park, MD

Flocculation Reduces Cation Exchange Capacity of Suspended Estuarine Sediment

The variation in the cation exchange capacity (CEC) of suspended sediment entering the Delaware Bay was determined as a function of salinity. Cation exchange capacity is based on Ca, Mg, Na, and K, the four commonest exchangeable ions. A comparison of the CEC (units in meq/100 g) of suspended sediment with salinity shows a sharp initial decrease from 73 meq/100 g at 0% salinity to a minimum value of 29 meq/100 g at 2.44% salinity, then a gradual rise to 48 meq/100g at 15.03% salinity. The observed trends between CEC and salinity were correlated with sampling conditions (depth, temperature, pH), mineralogy, iron III hydroxide and organic coatings, and the degree of particle flocculation. A very good ($> .90$) linear correlation exists between the degree of flocculation, expressed as the proportion of primary (individual, $< 2\mu$) particles, and the CEC's of the overall suspended sediment. The other variables do not show any significant correlation with the CEC-salinity trend. It is evident, therefore, that the process of flocculation leads to a decrease in CEC values. It is speculated that the process of flocculation is a function of the ionic strength of the water. The attraction or repulsion of suspended particles is a surface-charge phenomenon which is controlled by the ionic strength of the water.

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Transmission Survey Using Seismic Guided Waves: Cadiz, Ohio

When seismic survey energy is initiated within a coal seam, internally reflected S and P waves constructively interfere to form a seam wave. The seam wave is a high-frequency, dispersive wave which may exhibit both Rayleigh-type and Love-type modes. Since the seam wave is confined to the coal seam, its frequency content and dispersion characteristics are a function of the elastic properties and thickness of the coal seam. Large variations in the elastic properties or thickness of the coal seam, such as faults, sand bodies and pinch-outs, will affect the frequency and dispersion of the seam wave.

Seam-wave studies applied to coals in the eastern United States are few. The paper gives an acount of a transmission survey shot across a block of coal in the Oak Park Mine located near Cadiz, Ohio. The coal seam, under investigation is the lower Freeport (6A) which is 54 in. (14 cm) thick at the Oak Park Mine. Conducting an underground seismic survey presents many difficulties including: (1) mine accessibility; (2) underground-safety regulations; (3) source and receiver coupling; and (4) maneuverability. Comparison of the observed dispersion and predicted dispersion of the seam wave reveals its dominant mode and frequency content.

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Geochemical Controls on Aquia Aquifer in Maryland and Model for a Major Cation Source

The Aquia Formation is a Paleocene-Eocene glauconitic marine sand. It forms part of the Pamunkey Group of the Atlantic coastal plain. The geochemistry of the water in the Aquia aquifer, as shown by computer analysis, is controlled by the hydrologic flow regime and the mineralogy of the sediments. The ionic exchange of Na for Ca in glauconite and the dissolution of the sedimentary minerals are believed to be major sources of the cations in the aquifer waters. A model equation for the dissolution of glauconite has been developed and found to be thermodynamically feasible. The value for Gibbs free energy of formation for glauconite was estimated by a known method for layered silicates and found to be -1425 Kcal/mol. This produced a log Kiap/Keq ratio of -197 and shows glauconite undersaturated with respect to the formation water.

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Coal Geology of Lower Youghiogheny Basin, Garrett County, Maryland

The Lower Youghiogheny basin (130 sq mi or 338 sq km) ranks fourth in total area of the five synclinal coal basins of western Maryland. Approximately 1,000 ft (305 m) of coal-bearing strata of Early to Late Pennsylvanian is exposed (Pottsville, Allegheny, and Conemaugh Formations). The Pottsville Formation rests unconformably on the Mauch Chunk Formation of Late Mississippian. The contact separating the Pottsville and Allegheny Formations is the top of the Homewood Sandstone, and that separating the Allegheny and Conemaugh Formations is the top of the Upper Freeport coal bed. A coal bed correlated with the Little Clarksburg, which occurs in the upper third of the Conemaugh Formation in West Virginia, is