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GEOLOGY ANALYSIS OF WELL LOGS

Well logs serve many purposes. One part of log usage is directed toward evaluation of formation parameters: porosity, permeability, water saturation, and water salinity. Another, and perhaps the most extensive, part of log usage is applied to exploratory prospect or field-development studies related to correlation, and lithologic, structural, and stratigraphic definition. A survey of analytical practices supporting these studies finds that new logging methods and techniques are providing more direct and quantitative approaches to supplement subjective experience-based practices previously available.

The non-electrical logging methods, particularly the nuclear magnetic, density, and acoustic surveys, are affording additional opportunities for correlation and lithologic analysis. Digital dipmeter logging and oriented sidewall coring appear to be excellent sources for detailed data necessary for locating faults, relating a well's structural position to the prospect, or studying stratigraphic-structural inter-relationships. Computer processing is a key part of applied practices to exploit these new methods. Uniform log preparation for correlation and stratigraphic studies, dipmeter processing for structural analysis, and log combination for lithologic determination will be possible by computer processing of digital log data.

Many factors together form a log. The logging milieu contains a geologic model with numerous physical, chemical, and electrical properties, a bore-hole which produces effects obscuring geological information, and sophisticated tools which, together with variances in their operating mode, superimpose non-geological character on the log. Although some newer logging methods respond to fewer formation variables and are freer of bore-hole effects than older systems, unfortunately others are leaving their non-geologic fingerprints on the formation patterns. These factors combine to make technical understanding of the theory and practice of modern logging systems a necessary prerequisite to finding best uses and appreciating limitations of geological analysis of well logs.

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DISTRIBUTION AND RELATIONSHIPS OF SEDIMENTS AND ORGANISMS, MUGU LAGOON, CALIFORNIA

Prior to paleoecologic interpretation of fossils and their surrounding matrix, it is necessary to judge the adequacy of the geologic record to depict depositional site ecology. In a study of the ecology of Mugu Lagoon, several aspects of sediment and organism distribution are of interest. The aim of this work is to determine how well the Recent ecology of this area may be preserved in the record. The approach being used follows.

The *sediments* found within this physiographic setting are being analyzed in detail for grain size, organic matter, and carbonate. The significance of their distribution and character is being determined in relation to distance from the tidal inlet, tide levels, subaqueous and intertidal marsh vegetation, and fauna. Sedimentary structures from different environments of deposition are being described, and the importance of biogenic structures judged.

The *flora* of the lagoon is zoned by tidal level. Subtidal eelgrass serves as a refuge and feeding ground, and is being tested for an endemic fauna. Eelgrass and the salt marsh serve as an effective baffle system to trap fine-grained sediments; these are being studied for distinct structures and organism remains.

The *fauna* of the lagoon is being sampled, using $\frac{1}{4}$-sq. m. quadrats in conjunction with special dredging apparatus. Living organisms and shell remains are sorted, tabulated, and compared. In this manner the relations of the faunal elements can be compared to environmental parameters of the lagoon and to each other.

From preliminary results, the following points of paleoecologic interest can be made:

Post-depositional changes resulting from diagenesis and lithification commonly can be discovered with micro- or macroscopic techniques. Penecontemporaneous changes, caused directly or indirectly by the work of many kinds of organisms, may be quantitatively more important. These latter changes commonly are more difficult to discover and assess.

Although sediments and primary structures are functions of available material and energy, even moderate populations of animals can rework the sediments so that only biogenic structures are preserved, or the sediment can become apparently homogeneous.

Living populations of animals with hard parts are well represented by shell remains from the same quadrat, but absolute numbers of living and dead representatives of the same species are quite variable. Fossil population from this kind of environment should be largely in place, with little post-depositional transportation.

Rapid dissolution of shells can occur in some depositional environments.

Examples illustrating these points are presented.

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STRUCTURAL FEATURES OF NORTH TEJON-WHEELER RIDGE AREA

Both the North Tejon and Wheeler Ridge oil fields lie almost directly over the deeply buried portion of the White Wolf fault, but are found to occupy structures quite different in origin. The Wheeler Ridge anticline is one of a series of folds occurring along the southern border of the San Joaquin Valley. These folds and extensive thrust faults are easily recognized as the product of northerly directed compressive stresses. The principal North Tejon structure, located along the western side of Highway 99, has a north-south anticlinal axis striking nearly at right angles to the Wheeler Ridge axis, and does not have the related thrust faulting common to the other anticlinal folds.

Development of the North Tejon field showed the presence of numerous high-angle faults and revealed a segmentation of oil reservoirs into blocks containing oil of different gravities. The peculiar structure and distribution of Miocene basalt, capping most of the faulted reservoir rocks, and the gentle doming of formations lying above it indicate that the shape of the North Tejon structure resulted from an upwarping of the probably highly fractured basement rock with little regard to the existing faults.

A northeasterly regional tilt, accompanied by depression of gas-condensate-filled, former structural "highs" to positions below the level of present heavier oil- and water-bearing sandstones, has long been recognized in the segmented reservoirs at North Tejon field. Such a tilt may well have been caused by the large-scale sinking of the portion of the positive block of the White Wolf fault in the area just northeast of the field, which, like the negative block, was exposed to the very rapid

accumulation of Plio-Pleistocene debris derived from adjacent uplifts.

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STRATIGRAPHIC AND PALEOECOLOGIC SIGNIFICANCE OF DIATOMS AND SILICOFLAGELLATES

The west coast of North America has had marine environments particularly conducive to the accumulation and preservation of the most entensive deposits of diatomaceous sediments in the world. Inasmuch as this area can furnish dependable geological occurrences and, in turn, accurate stratigraphic ranges of diatom species from the Cretaceous to Recent, it can eventually become the standard of the world for diatom biostratigraphy. The following twelve floras have been described, they are: Late Cretaceous, 155 species, 136 restricted; late Eocene, 42 species, 19 restricted, largely planktonic species; early Oligocene, 51 species, 21 restricted, decreasing number of open-sea forms; middle Miocene, 82 species, 54 restricted, largely benthonic forms; late Miocene, 47 species, 7 restricted, mainly neritic to sub-littoral; late Miocene, 69 species, 24 restricted, mainly planktonic; late Miocene, 96 species, 52 restricted, mainly benthonic forms; late Miocene, 280 species, 145 restricted, mainly vagile benthonic and sessile littoral forms; early and middle Pliocene, 150 species, 70 restricted, planktonic forms in the lower and middle portion with bottom dwellers increasing in number in the upper portion; early Pliocene, 59 species, 18 restricted, mainly planktonic species with a minor number of brackish-water forms; late Pliocene, 101 species, 19 restricted, mainly planktonic species with a minor number of fresh-water forms; early Pleistocene, 136 species, brackish and fresh-water forms.

The diatoms also serve as a satisfactory check on the paleoecologic significance of diatomaceous deposits, not only because most diatoms are restricted to certain environments with regard to temperature, pH, and salinity, but also because they are restricted as to mode of life, *i.e.*, planktonic, neritic, vagile, and sessile benthonic, littoral, marine, brackish, and fresh water.

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PLIOCENE SEAKNOLL AT SOUTH MOUNTAIN IN VENTURA BASIN, CALIFORNIA

Extensive drilling in the southern Ventura basin in the last decade has provided useful data about Pliocene basin floor topography. The pre-basinal Miocene Modelo Formation, mainly siliceous shale, limestone, and organic shale with a bathyal microfauna, underwent extensive undersea tilting and faulting, resulting in a surface of high relief upon which the deep-sea Plio-Pleistocene Pico Formation was deposited. Among the land forms of this surface was a seaknoll at South Mountain.

Seaknoll features preserved include relatively uneroded fault scarps exceeding 40° in slope, a thin veneer of glauconite sandstone locally containing a talus of marine-laid Modelo limestone fragments from the scarps, and, near the seaknoll summit, a small biostrome in a shelly glauconite sandstone matrix. The steep fault scarps at South Mountain contrast with bevelled fault scarps at nearby Berylwood anticline and the Oxnard plain, on the site of a pre-Pico submarine slope eroded in the Modelo Formation.

The Pico Formation has onlapped and buried the seaknoll and the submarine slope. The Pico contains graded sandstones interbedded with siltstones containing indigenous bathyal and displaced neritic microfaunas. The sandstones shale out toward the seaknoll, suggesting that the seaknoll was mildly positive during sandstone deposition.

The submarine slope was scoured by bottom currents laden with sediment from subaerially eroded highlands toward the south and east. The seaknoll was unaffected by such currents because it was separated from highlands by deep-sea channels; hence its scarps were relatively unscoured by sediment-laden currents. Both submarine slope and seaknoll remained below sea level until buried.

Erosional submarine unconformities of the Berylwood and Oxnard plain submarine slope type are believed to be relatively common in basins where sedimentation and deformation have occurred simultaneously. Regarding these unconformities, the overlying sediments are of deep-sea rather than shallow-water origin, and are transgressive. The argument for submarine origin of the Mio-Pliocene unconformity in the southern Ventura basin, even where extensively eroded, is strengthened by the presence of the seaknoll, locally preserved from turbidity current scour, on which fault scarps and a glauconite-rich veneer have been preserved.

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CRUSTAL STUDY OF TRANSCONTINENTAL STRIP EAST OF ROCKY MOUNTAINS

A set of aeromagnetic profiles for a strip 100 mi. wide extending from the Rocky Mountains to the edge of the continental shelf off the eastern coast of the United States reveals large anomalies of major crustal significance. The data consist of 20 profiles flown at a barometric altitude of approximately 5,000 feet, centered along a line from Denver, Colorado, to Washington, D.C., and spaced approximately 5 mi. apart.

Several distinct anomalous patterns reflecting basement lithology can be clearly recognized. These include the Piedmont province in the eastern United States and the basalt flows in Iowa and Nebraska (mid-continent gravity "high"). The most intense anomalies occur in central and western Nebraska. Two anomalous areas in eastern Iowa and western Ohio probably are related to a single tectonic province and are correlatable with a pronounced horseshoe-shape gravity feature extending from eastern Iowa through eastern Minnesota across northern Lake Michigan and through the central part of Michigan and western Ohio. A linear magnetic anomaly at least 100 mi. long and 35 mi. wide is present over the Appalachian plateau and parallels the Appalachian structural trends.

The large amplitude and areal extent of the magnetic anomalies and their obvious correlation with known gravity anomalies suggest intrabasement units of correspondingly high acoustic velocities. It is clear that these vertical lithologic discontinuities must be taken into account in deep refraction studies of the crust and upper mantle; otherwise, seismic interpretations based on horizontal discontinuities alone yield incorrect crustal thicknesses.