BACKUS, MILO M., Geophysical Service, Inc.

SEISMOLOGICAL SIGNAL PROCESSING

The use of least-mean-square-error single and multichannel linear filtering for the reversal of signal alteration resulting from the seismic propagation path provides useful results in earthquake analysis and exploration seismology. The importance of the dispersive normal modes of propagation in layered elastic media and the time invariance of the seismic propagation medium are important, unique features of the seismic problem which contribute to the usefulness of this type of signal processing. Examples from exploration and earthquake seismology illustrate the techniques.

BALDWIN, THOMAS A., Humble Oil and Refining Co.

PACIFIC OFFSHORE EXPLORATION 1949–1965

The course of exploration offshore from the States of California, Washington, and Oregon can not be reduced fully to statistics. Three ingredients of the offshore effort are money, energy, and intelligence. The first two ingredients can be described in dollar expenditures (219 million dollars for leases alone), in miles of seismic line shot, or number of holes drilled. Contour maps of the dollar expenditures in the various areas of interest indicate how the first ingredient (money) was used, but contour anomalies on these maps suggest that the third ingredient (intelligence) either cannot be analyzed fully or has not been used in proper proportions. Vast areas of the offshore province remain unleased and unexplored, but past experience suggests that expansion into the new areas must be accompanied by expanded use of exploration intelligence if profits are to be realized.

BANDY, ORVILLE L., University of Southern California

RESTRICTIONS OF THE ORBULINID DATUM

Faunal evidence and potassium/argon dates suggest the approximate correlation of the Saucesian Stage of California with the Burdigalian Stage of Europe. The *Orbulinid datum* marks the approximate base of the Burdigalian Stage in deposits of deep-water origin within tropical and warm temperate areas. Orbulinids appear well above the base of the Burdigalian and Saucesian in temperate areas. Thus, it is suggested that it required from one to about two stages for orbulinids to adapt to the temperate zone after their initial appearance in the tropics.

BANDY, ORVILLE L., JAMES C. INGLE, JR., AND JOHANNA M. RESIG, University of Southern California

FORAMINIFERAL BIOFACIES, SANTA MONICA BAY, CALIFORNIA

Santa Monica Bay embraces an area extending more than 45 km. between Point Dume on the north and Palos Verdes Point on the south, and from the shoreline out into Santa Monica basin. Principal features are the mainland shelf (0 to 80 meters), the basin slope (80 to about 900 meters), and the basin floor which extends down to about 938 meters. The mainland shelf is a truncated positive feature separating the Santa Monica basin on the west from the filled Los Angeles basin on the east. Exposed Miocene-Pleistocene rocks on the shelf suggest this feature was formed during the Quaternary. Relict upper Pleistocene-Holocene sediments and faunas provide evidence of an episodic transgression of sea-level across the shelf.

Analysis of 85 bottom samples indicates that Recent sediments become finer offshore with the exception of relict grains, and nitrogen values generally are higher in the deeper, fine-grained sediments. Echinoderms and mollusks dominate the megafauna near the edge of the shelf.

General foraminiferal trends are: foraminiferal abundance increases offshore; live specimens are most abundant in the central shelf area; living species are most abundant in the central shelf area and in the bathyal zone; higher live/dead ratios occur on the central and outer shelf in areas of slow deposition; arenaceous types dominate dead populations on the central shelf; and live hyaline types are more than 8 times as abundant as live arenaceous forms in most areas.

Inshore foraminiferal groups are characterized by species of *Rotorbinella*, *Discorbis*, and *Elphidium*. Open shelf biofacies are characterized by *Buliminella elegantissima*, *Eggerella advena*, *Bulimina marginata denudata*, and *Trochammina pacifica*. Species of *Nonionella*, normally abundant, are relatively rare, possibly because of ocean pollution. A *Bolivina acuminata* group of species is characteristic of the shelf edge and the upper basin slope. A deeper water *Bolivina argentea* basin facies appears at about 400 meters and is dominant on the floor of Santa Monica basin.

BECK, R. STANLEY, Consultant

BIOSTRATIGRAPHIC HIGHLIGHTS OF SOME DEEP WELLS FROM CENTRAL-SOUTHERN SAN JOAQUIN VALLEY, CALIFORNIA

The wells to be discussed are the Kings County Von Glahn No. 1, Sec. 4, T. 23 N., R. 22 E.; Harry H. Magee Amalgamated Happold No. 2, Sec. 15, T. 25 S., R. 24 E.; Continental KCL A-2, Sec. 8, T. 27 S., R. 24 E.; Western Gulf KCL B-45, Sec. 22, T. 29 S., R. 27 E.; Humble KCL D-2, Sec. 15, T. 30 S., R. 27 E.; Ohio KCL A-72-4, Sec. 4, T. 32 S., R. 26 E.; and Humble KCL B-11, Sec. 35, T. 11 N., R. 21 W.

The above wells include more than 21,000 ft. of Pleistocene to Upper Cretaceous (?) sediments that were deposited in non-marine to deep-water marine environments. Thickening and thinning of beds, as well as changes in the biofacies and lithofacies, take place quite rapidly between well locations. In the Ohio KCL A-72-4 and many adjacent wells, "deep water pseudo-Saucesian" foraminiferal species often recur within middle and late lower Miocene intervals. The Humble KCL B-11 and many other wells on or near the major fault systems contain good examples of repetition of faunas resulting from overturned beds and faulting.

BEDFORD, J. W., Texaco Inc.

GREAT ALASKAN EARTHQUAKE AND ITS AFTER EFFECTS

One of the greatest earthquakes ever recorded struck Alaska on March 27, 1964, causing an estimated 750 million dollars in property damage and the loss of 115 lives.

The earthquake epicenter was located at the head of Prince William Sound, 75 miles east of Anchorage. Approximately 12,000 aftershocks had been recorded by October, 1964. Aftershock epicenters extend in a belt 50 to 140 miles wide between Prince William Sound and Kodiak Island, a distance of over 500 miles. Uplifts of as much as 50 feet and horizontal shifting of 10 to 20 feet have been reported along the southeastern portion of this belt. A large area toward the northwest subsided as much as 6 feet.

Submarine landslides destroyed the waterfronts of Seward, Whittier, and Valdez. Landslides generated sea waves, and tsunamis caused additional damage.

In Anchorage, the jarring action of the earthquake liquefied sensitive sand and clay zones, causing large landslides which destroyed residential and downtown business areas. Long-period surface waves caused extensive damage to many large buildings. Detailed geological and soils studies have not been completed by government agencies and consulting firms. Recommendations have been made for future land use and for stabilization of two major slides by a gravel buttress and an underground sand-pile buttress.

BERRY, KEITH D., Standard Oil Co. of California, Western Operations, Inc.

NEW FORAMINIFERAL ZONATION, UPPER MESOZOIC, SACRAMENTO VALLEY, CALIFORNIA

Six new foraminiferal zones have been established in the upper Mesozoic of the Scaramento Valley, California, as the result of detailed micropaleontological work in conjunction with several reconnaissance field mapping projects. The letter designations I, J-1, J-2, K, L, and M are proposed for these microfaunal zones. These designations are a downward continuation of the Upper Cretaceous zones of Goudkoff, who established the A through H Zones in 1945. The rocks on which this new zonation is based range in age from lower Early Cretaceous, Cenomanian stage, through Late Jurassic, Tithonian stage. Micropaleontological work is essential for mapping of this thick clastic sequence, because of the gross lithologic similarity and the lenticular, disconnected, and time-transgressive nature of the coarse clastic marker beds. This study covers a 150 mile ± section along the regional strike of the outcrop along the western side of the Sacramento Valley, and also extends into the Redding area on the northeastern side of the valley.

Over 600 species, many of them new, and approximately 100 genera, including some new, were checklisted or recorded from more than 30 outcrop and well sections in the area. The new zones have been correlated approximately with the European stage classification. The I, J-1, and J-2 Zones range from Cenomanian to Aptian on the basis of both planktonic and benthonic Foraminifera; the K, L, and M Zones range from Barremian to Tithonian on the basis of cosmopolitan benthonic species. Correlations also were made between microfossil localities and northern California megafossil localities which have been equated with the European standard section.

Specific criteria for identification of the H Zone were not established by Goudkoff, but detailed study permits both identification and biofacies differentiation within it. The abundant and varied microfaunas of the "Middle" Cretaceous have made it possible to distinguish the I from the J Zones, separate the closely related J-1 and J-2, and divide the J-1 into three sub-Zones. The K, L, and M Zones are more difficult to differentiate, because of the absence of planktonics and the predominance of many similar *Nodosariidae*. The M Zone probably can be subdivided if more comprehensive work is done.

There is no faunal indication in the outcrop section of any unconformity between the Upper and Lower Cretaceous. Many species range through both Albian and Cenomanian sediments, without apparent interruption.

BILLMAN, HAROLD G., Union Oil Co. of California

REVIEW OF TERTIARY STRATIGRAPHY AND FORAMINIFERAL ZONATIONS OF WESTERN WASHINGTON STATE

Tertiary marine sediments and volcanic rocks ranging in age from early Eocene to late Miocene, or possible Pliocene, are present in southwestern Washington State. Total thickness of these rocks is more than 50,000 feet.

The Eocene history of the area is characterized by widespread vulcanism. Sedimentary rocks definitely dated as early Eocene have not been found in southwestern Washington. Middle Eocene rocks are represented by volcanics and interbedded sediments of the Crescent Formation and typically contain *Amphistegina california* and *Asterigerina crassiformis*. Upper Eocene rocks are represented by the marine Raging River Formation and the non-marine Puget Group in the eastern part of the area. To the southwest, equivalents of these formations range from marine to non-marine facies and are mapped as McIntosh, Northcraft, Skookumchuck, and Cowlitz Formations. Further west, upper Eocene rocks are wholly marine and are mapped as the Cowlitz Formation. Total thickness of middle and upper Eocene rocks is at least 15,000 feet. Foraminiferal zones equivalent to Laiming's B Zones and B-1-A, A-2, and A-1 Zones of the California Eocene can be identified.

In early Oligocene time, regional subsidence, accompanied by notable pyroclastic vulcanism, took place and Oligocene rocks are characteristically tuffaceous.

Rocks assigned an Oligocene age have a maximum thickness of 9,000 feet in southwestern Washington and comprise the Lincoln Formation. Two lithologic members usually are distinguished: a lower basaltic sandstone member and an upper tuffaceous siltstone member. Three foraminiferal zones are recognized and are correlated with the Refugian and Zemorrian stages of California.

In early Miocene time, deposition continued uninterrupted in the same basins that were receiving Oligocene sediments. In middle Miocene time widespread diastrophic activity was accompanied by withdrawal of the seas from southwestern Washington, except along the present Pacific Ocean front and a deep embayment in the Grays Harbor-Montesano area.

In the Chehalis basin, Miocene sediments consist of 2,000 feet of wholly non-marine rocks comprising the Astoria (?) Formation (early Miocene) and Wilkes Formation (late Miocene).

In the Grays Harbor-Montesano basin, lower and middle Miocene rocks consist of an estimated 6,000 feet of marine sediments mapped as the Astoria Formation. The Astoria Formation is subdivided informally into three lithologic units which are assigned an early and middle Miocene age, equivalent to the Saucesian, Relizian, and possibly Luisian stages of California.

At Ocean City, sediments notably different from the typical Astoria Formation are correlated tentatively with the lower portion of the Astoria Formation.

Marine sediments of late Miocene to questionably Pliocene age occur only in the Grays Harbor-Montesano basin and the Pacific Ocean coastal strip. In the Grays Harbor-Montesano basin, these rocks are mapped as Montesano Formation and consist of 2,500 feet of marine conglomerate, sandstone, and siltstone containing Foraminifera which indicate a late Miocene age equivalent to the Mohnian and Delmontian stages of California. Along the Pacific Coast, in the vicinity of Ocean City, sediments of equivalent age are represented by up to 6,000 feet of sediments informally denominated