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# DEEP-WATER HYDROCARBON EXPLORATION IN THE PHILIPPINES

APOLLO P. MADRID
Bureau of Energy Development, Ministry of Energy Building, Merrit Road,
Fort Bonafacio, Makati, Philippines

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**Abstract**—Deep-water drilling in the Philippines began in 1979 and ten wells were drilled over the next three years. The primary targets were Miocene reef limestones, which were found not only to be well developed in the geologic column but also to attain considerable size. Proven oil production from Miocene reefs in shelf waters off Northwest Palawan have encouraged explorationists to focus on the adjacent deep-water areas. The hydrocarbon potential of offshore areas deeper than 200 m was manifested by a commercial oil discovery and a noncommercial gas discovery in Lower Miocene turbidite sands and a gas discovery in Lower Miocene reefal limestone off Northwest Palawan. The Galoc oil discovery in a water depth of 1055 ft is scheduled for development beginning in late 1983 and oil production is programmed to start during the first quarter of 1985. The Galoc development/production scheme calls for an Early Production System (EPS) consisting of a floating production facility (FPF) and subsea well completions. Institutional incentives have been developed by the Philippine government to encourage deep-water exploration. The incentives include a longer exploration period, cross-recovery of exploration expenses, depreciation of tangible exploration costs over a five-year period, and up to two-thirds reimbursement on loan interest for financing development and production.

## INTRODUCTION

There are 12 major onshore/offshore sedimentary areas in the Philippines (Fig. 1). Except for Palawan–Mindoro and the southwest Sulu Sea, all the basins are closely related to Neogene volcanic island arcs. Palawan and Mindoro are believed to be continental fragments or microcontinents, whereas the southwest Sulu Sea Basin is similar to the Tertiary basins that flank the continental core of the island of Borneo.

Petroleum exploration started at the turn of the century and the first onshore wells were drilled in areas with known oil seeps in the island of Cebu in the central Philippines and in the Bondoc Peninsula in southern Luzon. From 1900 to 1970 a total of 255 onshore wells were drilled. The only significant finds were a noncommercial gas discovery in the Cagayan Basin in northern Luzon from Upper Miocene reefal limestone and a noncommercial oil discovery in northern Cebu from Middle to Late Miocene sands.

Offshore exploration in the Philippines started in 1971 with the drilling of two wells offshore of Northwest Palawan. Subsequent offshore wells in the early to mid-1970s were concentrated in West Palawan and the southwest Sulu Sea. Over a 12-year period from 1971 to 1982, a total of 97 offshore wells were drilled in Philippine waters including those offshore of northern Luzon, east Luzon, and the central Philippines.

The first significant offshore oil discovery was the Nido-1 well in Northwest Palawan drilled by Cities Service in March 1976 (Fig. 2). Although the discovery proved later to be noncommercial, it paved the way for the drilling of Lower Miocene reefal limestone prospects. The South Nido-1 well drilled in July 1977 was the first commercial oil discovery and was put into production in February 1979. The oil comes from the same Lower Miocene reefal limestone (Nido Limestone) with an API gravity of 27°.

The second commercial oil discovery was made by AMOCO north of Nido from a similar carbonate reservoir. The Cadlao discovery was made in October 1977 and production started in August 1981. The oil has an API gravity of 47°. The third commercial discovery in Lower Miocene limestone was also made by Cities Service in the Matinloc Complex in December 1978 and production started in July 1981. The oil has an API gravity of 44°.

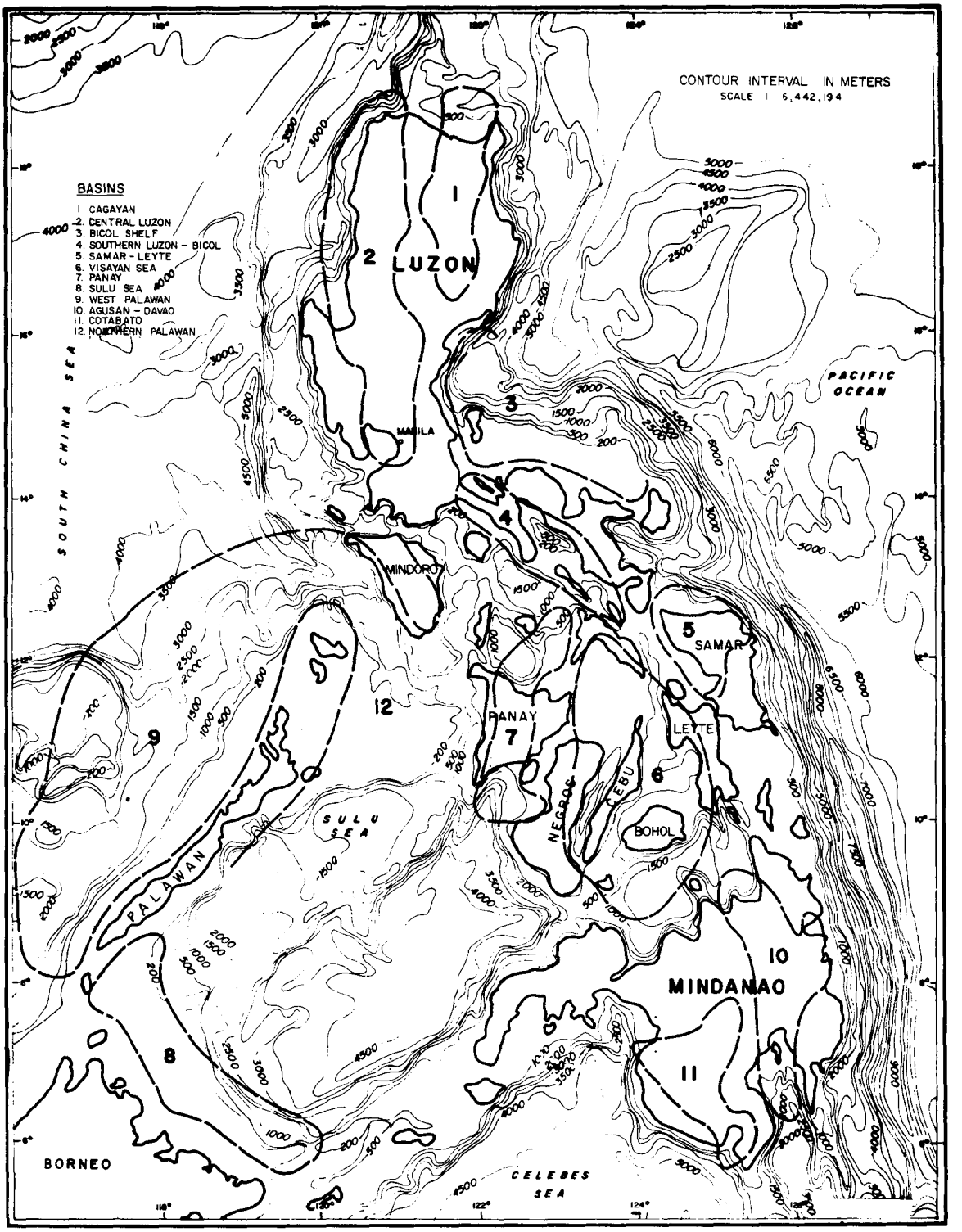


Fig. 1. Sedimentary basins of the Philippines.

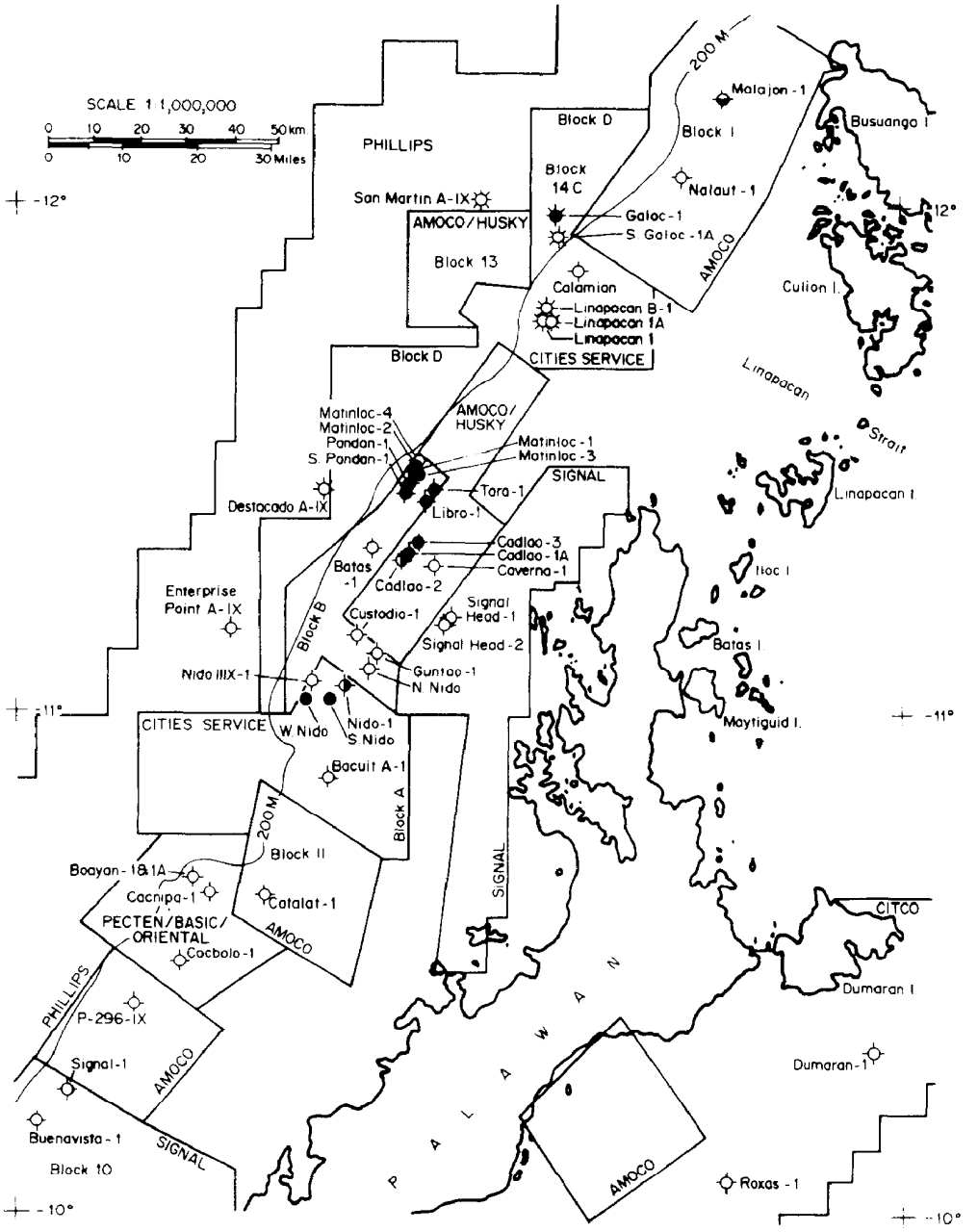


Fig. 2. Petroleum activity, Northwest Palawan, Philippines.

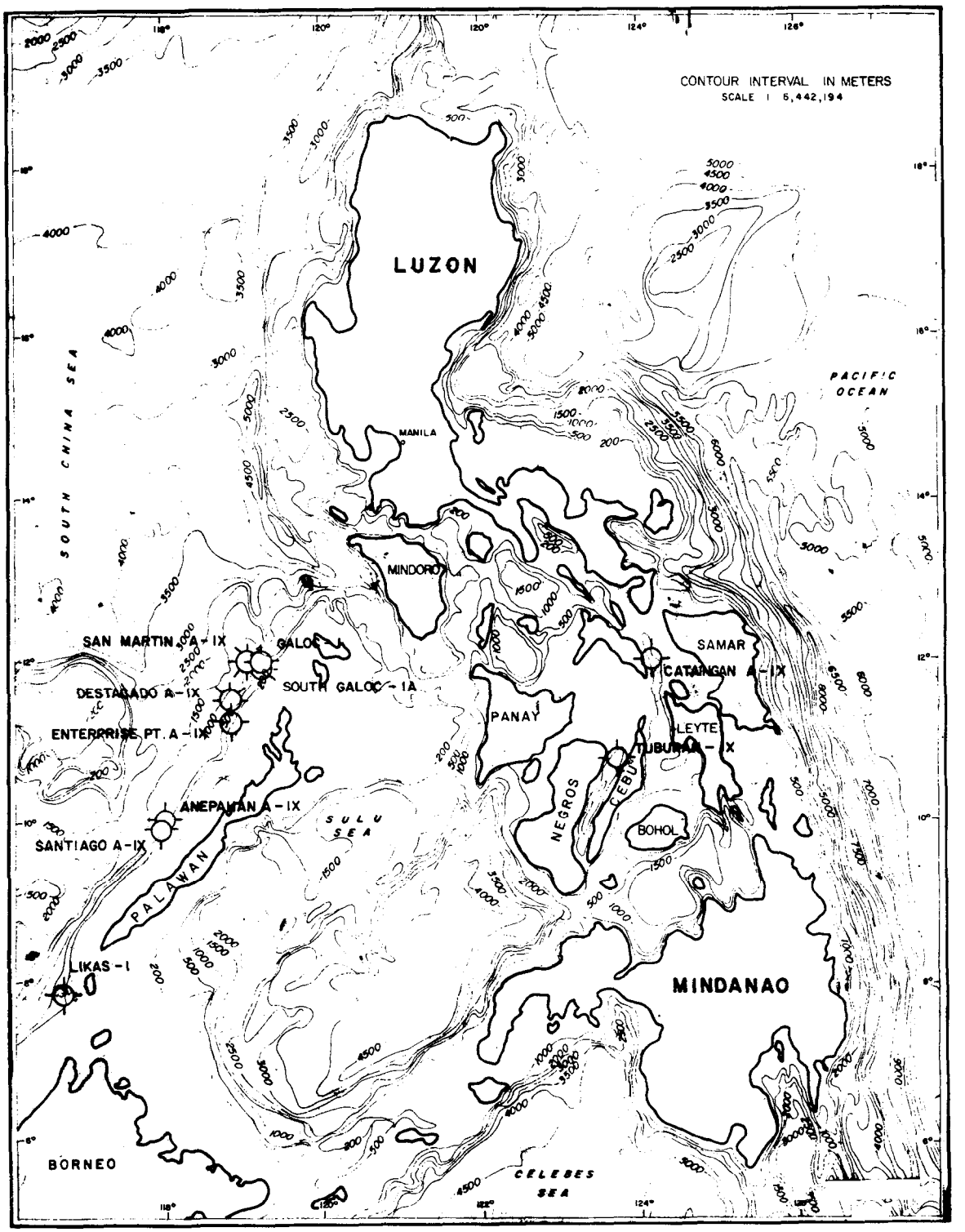


Fig. 3. Deep-water exploration wells.

Table 1. Deep-water hydrocarbon exploration in the Philippines (1979–1982).

| Well Name | Operator | Location | Water Depth (ft) | Total Depth (ft) | Rig Type | Drilling Target | Remarks |
|---|---|---|---|---|---|---|---|
| Likas-1 | Pecten Philippines | SW Palawan | 650 | 6,178 | Fredericksburg/ Drillship | Upper Miocene limestone Middle Miocene sandstone | Dry well |
| Cataingan A-1X | Phillips Petroleum | NE Cebu | 607 | 5,438 | Penrod 74/ semi-sub | Upper Middle Miocene limestone | Dry well |
| Tuburan-1X | Phillips Petroleum | NW Cebu | 1,283 | 11,633 | Penrod 74/ semi-sub | Upper Middle Miocene limestone | Dry well |
| Santiago A-1X | Phillips Petroleum | W Palawan | 1,283 | 10,602 | Penrod 74/ semi-sub | Lower to Middle Miocene limestone | Dry well |
| Galoc-1 | PCSI | NW Palawan | 1,055 | 12,141 | Penrod 74/ semi-sub | Lower Miocene limestone | Oil discovery |
| South Galoc-1A | PCSI | NW Palawan | 737 | 8,576 | Dixilyn Field 95/ semi-sub | Lower Miocene sandstone | Gas discovery |
| Enterprise Point A-1X | Phillips Petroleum | NW Palawan | 1,198 | 8,225 | Penrod 74/ semi-sub | Lower Miocene-Oligocene limestone | Dry well |
| Anepahan A-1X | Phillips Petroleum | W Palawan | 1,453 | 9,000 | Penrod 74/ semi-sub | Lower Miocene-Oligocene limestone | Dry well |
| Destacado A-1X | Phillips Petroleum | NW Palawan | 1,767 | 12,484 | Penrod 74/ semi-sub | Jurassic-Cretaceous limestone | Dry well with gas shows |
| San Martin A-1X | Phillips Petroleum | NW Palawan | 1,182 | 4,282 | Penrod 74/ semi-sub | Lower Miocene limestone | Gas discovery |

## DEEPWATER EXPLORATION

Explorationists normally look into the onshore as well as the deep-water extensions of shelfal basins in the course of their evaluation of the petroleum potential of any basin. Seismic profiles in deep water indicated the presence of large carbonate buildups of apparently the same Miocene age as the proven oilfields of Northwest Palawan. Table 1 is a tabulation of deep-water wells in the Philippines drilled from 1979 to 1982; Fig. 3 shows their locations.

In 1979, Pecten drilled the first well beyond the 600-ft water depth, the Likas-1 well. It was drilled at a water depth of 650 ft, but the Upper Miocene limestone target proved to be dry and the anticipated Mid-Miocene sands were not well developed. From late

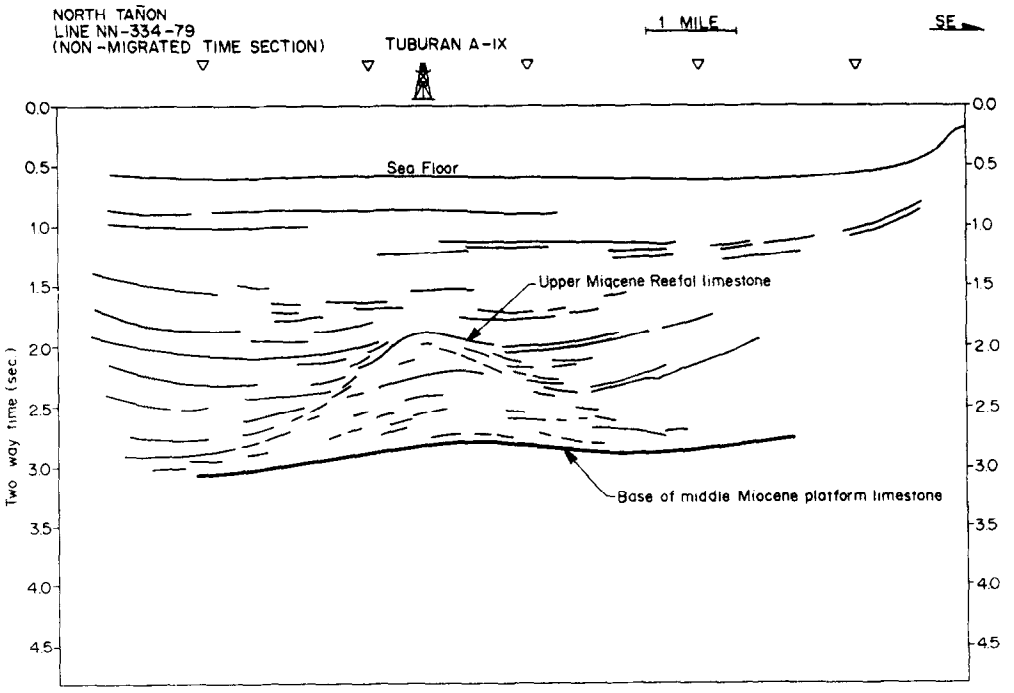


Fig. 4. Tuburan structure.

1979 to early 1980, Phillips drilled the Cataingan-1 and Tuburan-1 wells in the central Philippines at water depths of 607 ft and 1283 ft, respectively, over Miocene reefal limestone prospects.

The Tuburan prospect has an areal closure of 22,000 acres and a vertical closure of 5500 ft (Fig. 4). Drilling results indicate the reef limestone to be Mid- to Upper Miocene in age (Fig. 5). No hydrocarbons were found and both wells were subsequently plugged and abandoned. From 1981 to 1982, Phillips moved their exploration efforts to west Palawan, where five deep-water wells were drilled: four in Lower Miocene limestone prospects and one in a Mesozoic bedded-limestone play.

The Anepahan prospect lies at a water depth of 1453 ft and has an areal closure of 5500 acres and a vertical closure of 1900 ft (Fig. 6). The limestone reservoir was dry and the well was plugged and abandoned at a total depth of 9000 ft (Fig. 7). The Destacado-1 well is situated at the deepest offshore location in the Philippines at a water depth of 1767 ft. The Destacado prospect was mapped on a large Mesozoic fault block with an areal extent of 7000 acres and a vertical closure of 1500 ft. Anticipated primary reservoirs were Lower Cretaceous limestones with Lower Miocene limestone as a secondary target. The results of drilling the Destacado-1 well showed instead a clastic sequence of shales, siltstones, and indurated sandstones of possible Early Cretaceous age (Fig. 8). Lower

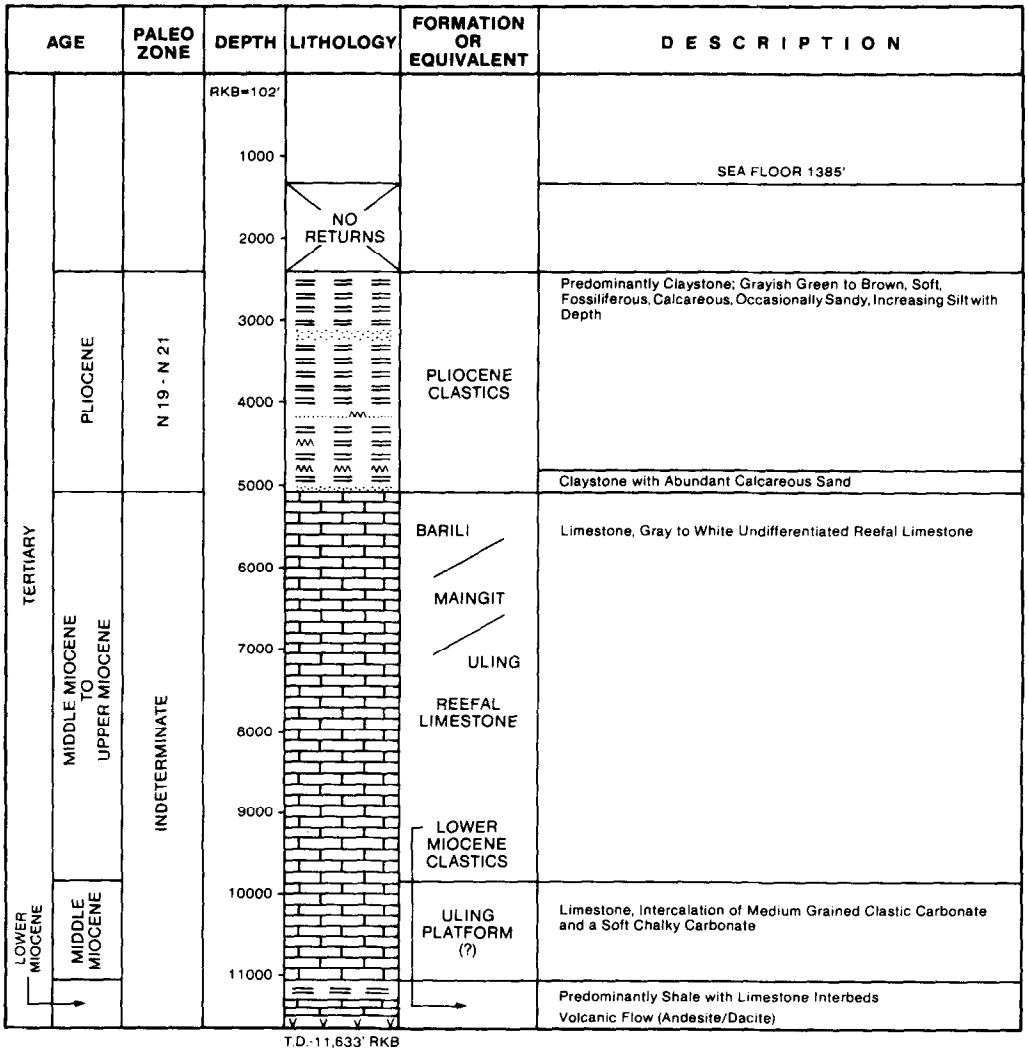


Fig. 5. Stratigraphic column, Tuburan-IX, Northwest Cebu.

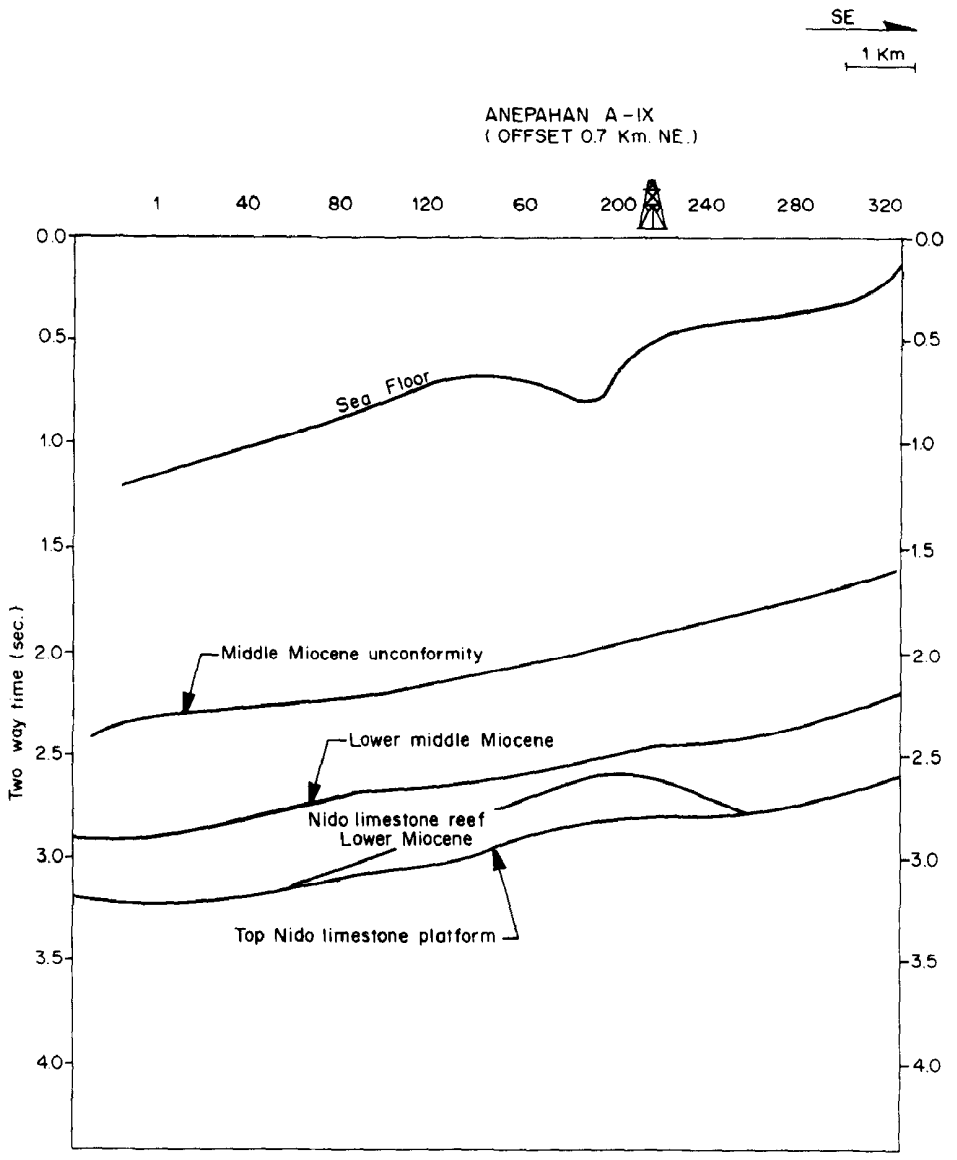


Fig. 6. Line WP 202-80, migrated time section.

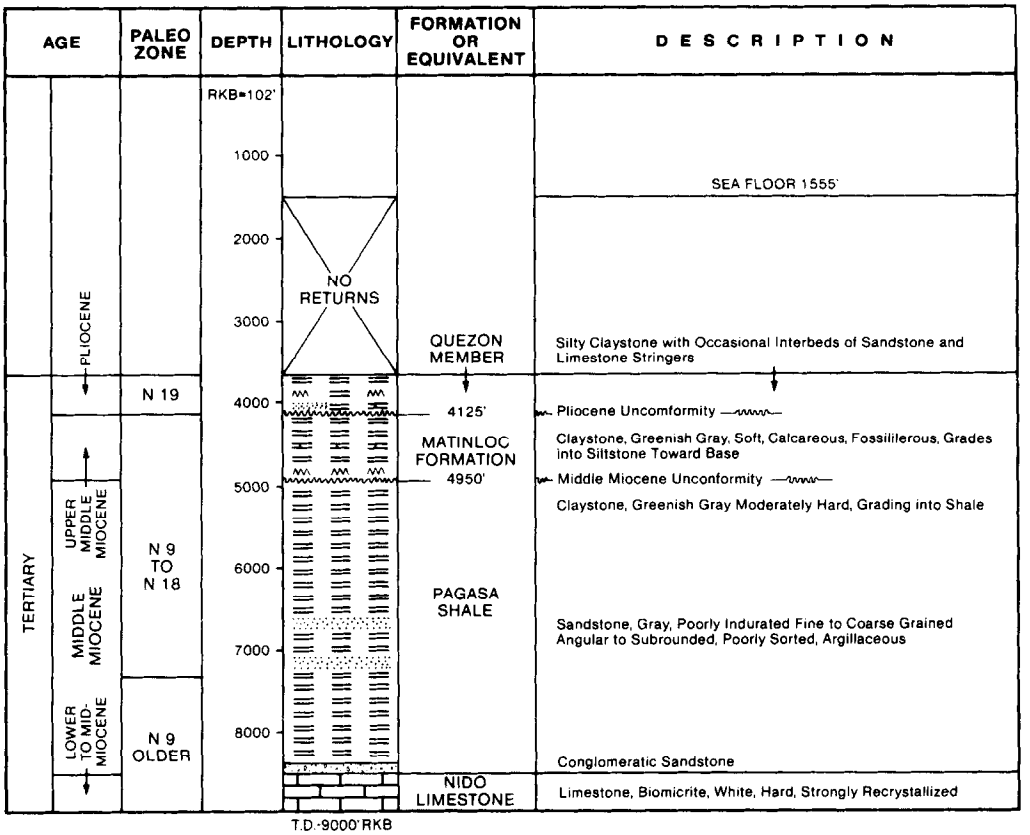


Fig. 7. Stratigraphic column, Anepahan A-IX, Southwest Palawan.

Miocene limestone is present and tested some gas during drill-stem testing. The well was plugged and abandoned.

Further offshore of Northwest Palawan, Phillips drilled the San Martin prospect at a water depth of 1182 ft. The target is a huge Lower Miocene platform limestone with several reef culminations (Fig. 9). The structural closure is 31,000 acres and the vertical closure is 1700 ft. The San Martin-1 well penetrated the Lower Miocene limestone and bottomed in calcareous Eocene sandstones. This well tested gas from the limestone reservoir during a drill-stem test and was plugged and abandoned as a gas discovery.

Cities Service, in their continued exploration of the Lower Miocene limestone play, have delineated several prospects and leads north of their service contract area. The North Galoc and South Galoc structures were initially interpreted as either carbonate buildups or a turbidite sand pile based on their configuraiton. The Galoc structure lies in water depths between 800 and 1200 ft (Fig. 10). The Galoc-1 well was drilled in August 1981 in a water depth of 1055 ft. The projected reefal limestone buildup turned out to be a sequence of claystone and siltstone with some coarse clastic interbeds. This clastic sequence is now interpreted as an Early-Miocene–age turbidite. The base of the mapped anomaly is a coarse-grained clastic sequence with turbidite characteristics and is oil-bearing. Underlying this coarse turbidite sequence is a thick basinal limestone of Late Oligocene to Early Miocene age (Nido platform limestone) with oil shows. The well bottomed in possible Jurassic metasediments (Fig. 11).

The Galoc-1 well had flow rates during tests of 1600 to 1800 BD of 32° to 36° API-gravity oil through a 3/4-in. choke. The South Galoc-1 prospect, some 5 km south of North Galoc, was drilled to follow up the oil-productive turbidite sands in Galoc-1. The South Galoc-1 well was found to have equivalent turbidite sands although they were

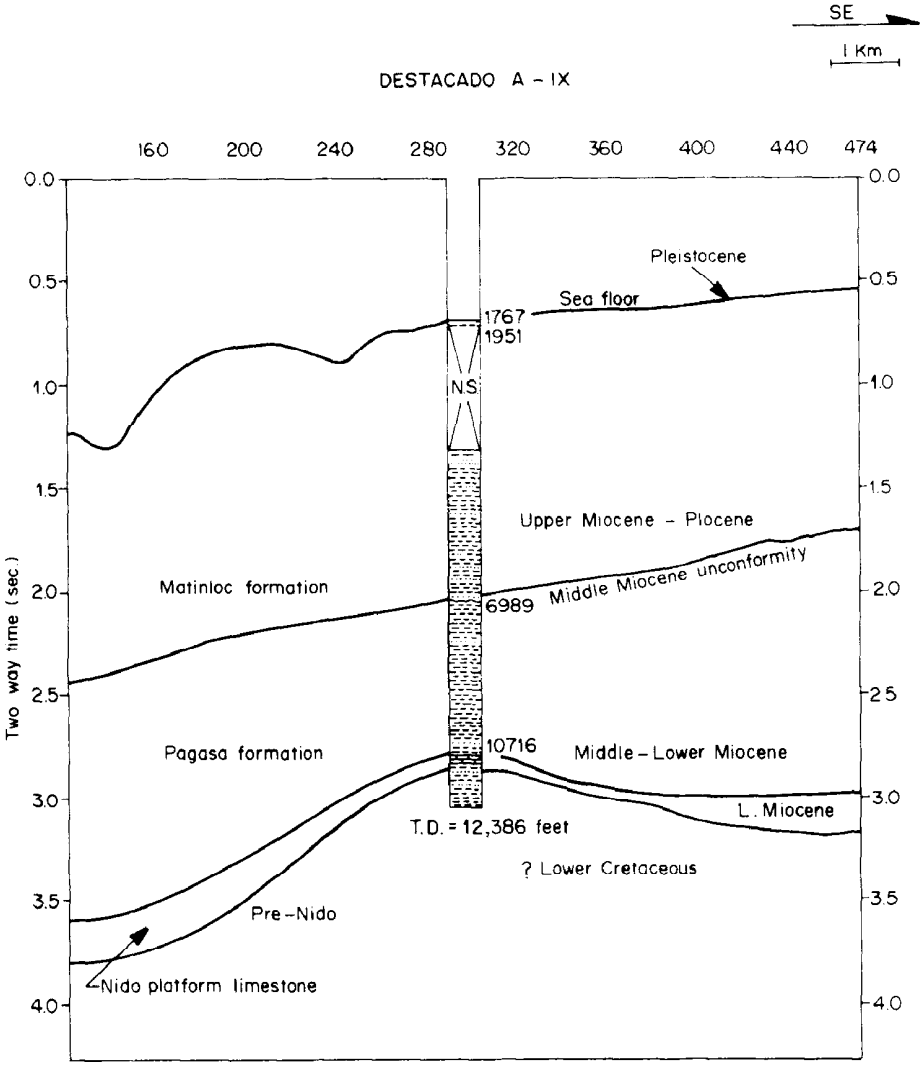


Fig. 8. Line NWP 352-80, migrated time section.

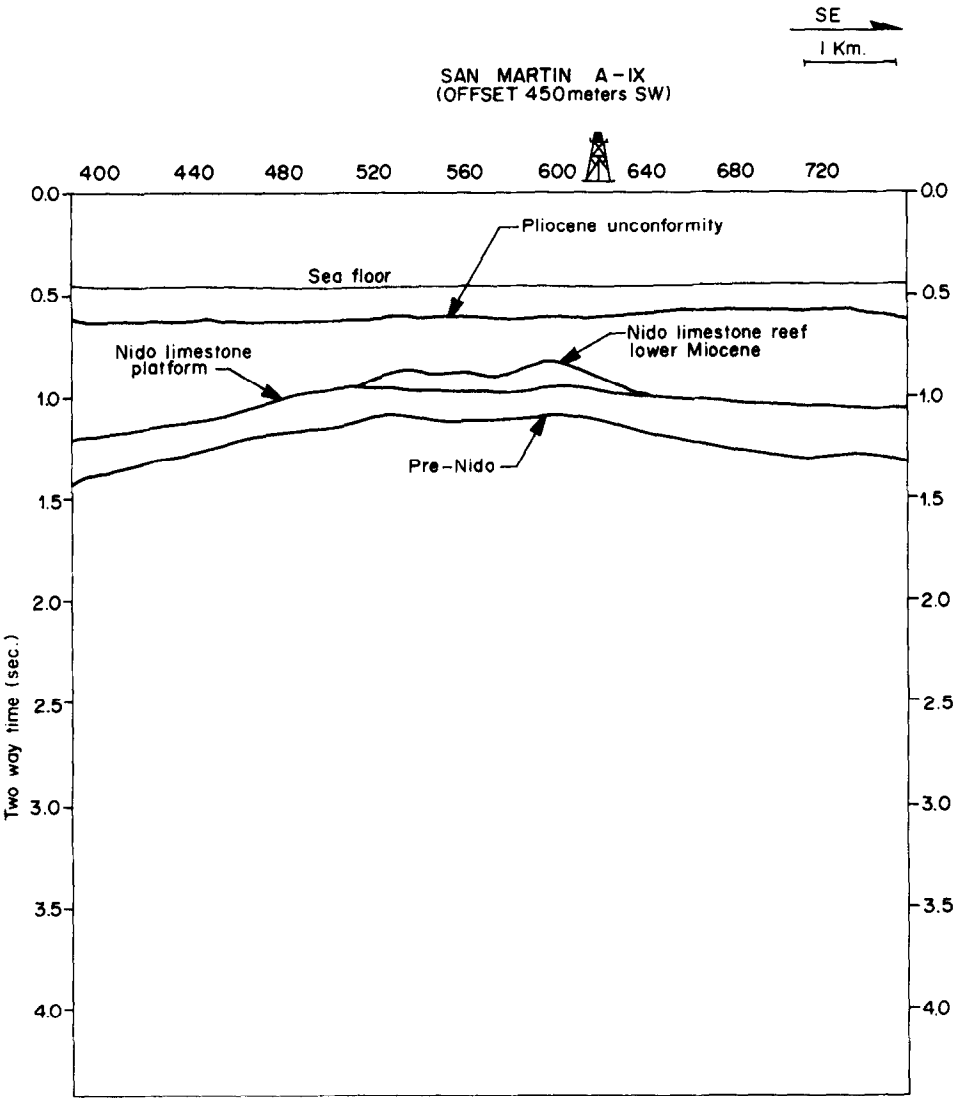


Fig. 9. Line NWP 524-81, migrated time section.

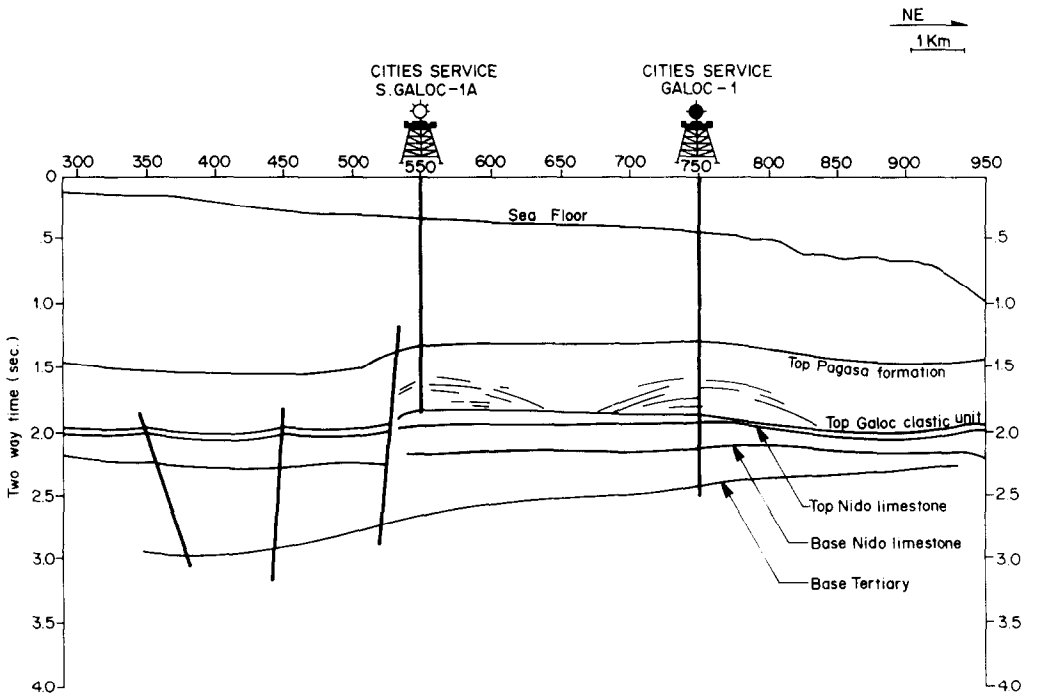


Fig. 10. Line 79-900.

thinner and gas-bearing. The hydrocarbon-bearing sands of the Galoc structures are believed to be associated with a submarine fan complex.

The Galoc oil and gas discoveries are significant in the history of petroleum exploration in the Philippines. This is the first time that oil has been tested in commercial quantities from a sandstone reservoir. It is also important to note that the discovery was made in what was previously thought of as an area of primarily carbonate play.

Cities Service is finalizing plans to put the North Galoc oil discovery into production. The development scheme calls for an Early Production System (EPS) consisting of two subsea well completions, a floating production facility (FPF) and a tanker mooring system. Commissioning of the Galoc EPS is scheduled for the end of the first quarter of 1985; it will be the first deep-water production facility in Southeast Asia. Areas in water depths greater than 600 ft considered to have petroleum potential are those in east and west Palawan as well as the Sulu Sea. These areas are considered prospective by virtue of the quartzose nature of the sandstone reservoirs.

## INSTITUTIONAL INCENTIVES

In view of the high costs and difficult logistics involved in deep-water areas, the Philippine government developed several institutional incentives to encourage petroleum exploration. Under Presidential Decree 1857, which became effective January 1, 1983, the incentives are:

1. maximum exploration period in deep-water areas of 15 years;
2. expenses chargeable to recoverable costs not exceeding 70% in any given year. The contractor may also deduct amortization and depreciation of tangible exploration costs for a period of 5 years. In addition, interest for development and production financing shall be reimbursed to the extent of two-thirds of the amount thereof;
3. expenses in a deep-water contract can be recovered in another deep-water contract subject to graduated rates;

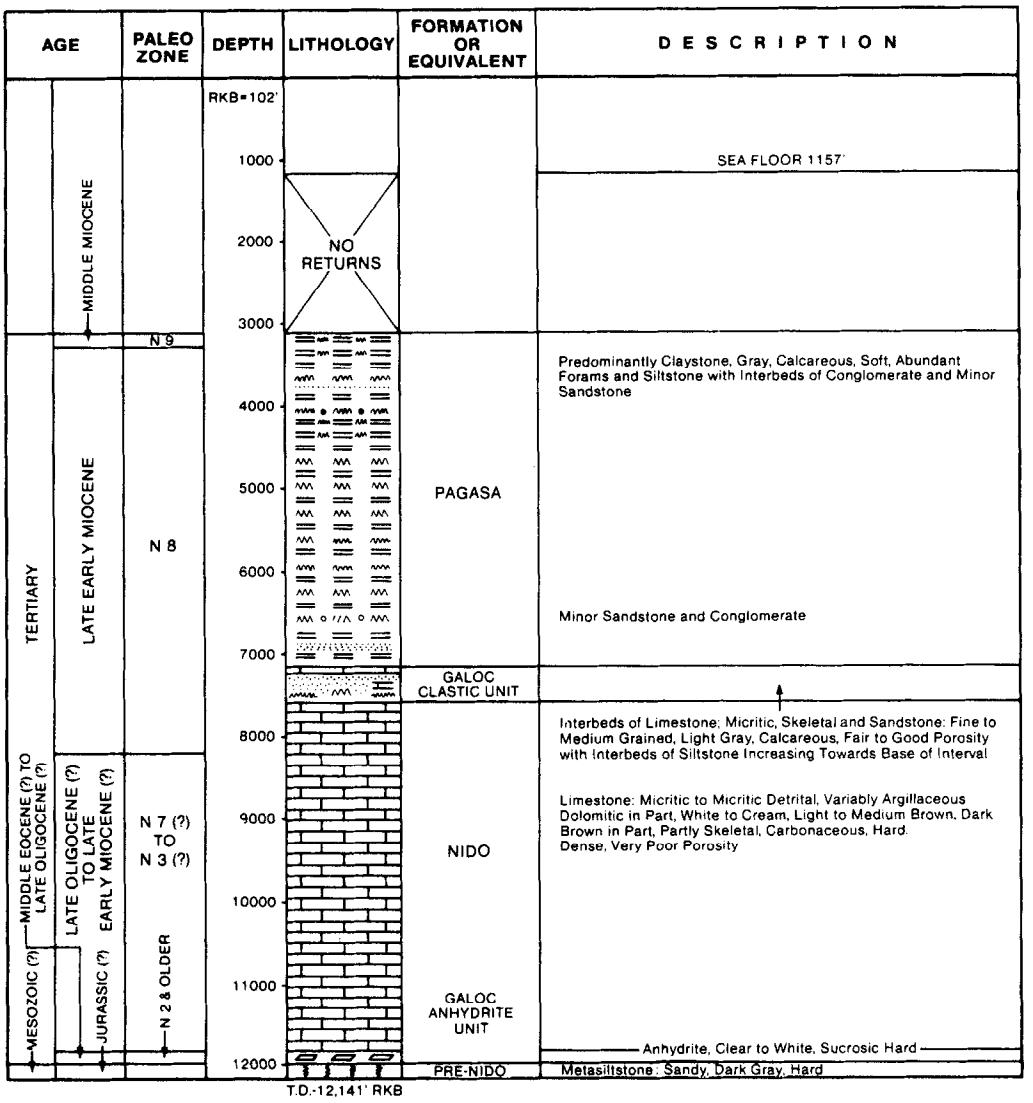


Fig. 11. Stratigraphic column, Galoc-1, Northwest Palawan.

4. cross-recovery of operating expenses shall be allowed only for a 10-year period starting January 1, 1983; and

5. exemption for the investment requirements for foreign corporations of the Corporation Code of the Philippines.

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