

have been published on recent energy studies in Peru, Egypt, and Portugal; and similar reports will be available in the near future for Argentina and South Korea. Other countries for which preliminary reports have been prepared recently include: Pakistan, Indonesia, Bangladesh, Turkey, Costa Rica, Morocco, Mexico, Trinidad, Venezuela, USSR, the members of ECOWAS (Economic Community of West African States), and nations in the Persian Gulf area.

BISHOP, ROBERT A., Amoco Production Co., Denver, Colorado

Undrilled Reserves in Cook Inlet Oil Fields, Alaska

The Middle Ground Shoal and Granite Point fields in the Upper Cook Inlet, Alaska, are major oil fields discovered seismically 20 years ago. Development drilling was based on a structural model of an anticlinal ridge bounded by large thrust faults intersecting at depth in a cross sectional "V" configuration. The oil-bearing zones of the Middle Ground Shoal field were originally believed to be confined to a relatively small anticlinal area near the bottom of the fault-bounded "V." Wells were deviated from offshore platforms, and in places where a well was deviated from one flank to the other, the borehole was initially normal to bedding until the axial plane of the fold was crossed and the other limb encountered. From that point, the borehole continued down the limb parallel to the bedding, and was interpreted as having intersected the fault plane.

Additional well data and a review of older well logs indicated that the faults might not exist. If this were the case, the flanks of the structure were not being drained. A similar interpretation was shown to be applicable to the Granite Point field by a well drilled to test this same hypothesis. The well was directionally drilled in the shape of an open hook, deviating 4,000 ft (1,220 m) to the west, then curving back to the east so that the west flank would be encountered normal to the bedding. The well intersected the west dipping flank, which was not faulted, and was completed for 400 bbl of oil per day. A second well is now being drilled.

BLAKE, F. A., and A. J. ANDERSON, ARCO Power System, Littleton, CO

Solar Enhanced Oil Recovery Project Using Heliostats

(No abstract)

BOGDANOV, N. A., Inst. Lithosphere, USSR Academy of Sciences, Moscow, USSR

Tectonic Evolution of Pacific Ocean

In accordance with the lithosphere plate theory, the western part of the Pacific Ocean was occupied by an oceanic basin prior to the disintegration of Pangea. Linear magnetic anomalies and DSDP data indicate that the oldest oceanic crust is Late Jurassic in age. Little is known about the boundaries of the proto-Pacific plate and its fragments in the western part of the Pacific Ocean, but it is obvious that the oceanic crust fragments of this age occur along the western rim of the basin from the Koryak Mountains in Asia to eastern Australia as well as in various foldbelts on the east in Alaska and the Klamath Mountains. The most intensive tectonic movements and spreading within the Pacific Ocean, accompanied by subduction along both sides of the oceanic plate, occurred near the end of the Jurassic

(Kimmeridgian-Tithonian) and during Early Cretaceous time (Aptian-Albian). A result was the formation of the Kula plate with tectonic nappes which stand as such submarine dome rises as the Shatsky Rise, Manihiki Plateau, Hess Rise, and Campbell Plateau, characterized by double thicknesses of oceanic crust. By comparing differences in Albian-Aptian facies, between the east Pacific Ocean and the west, it is possible to assume that shallow-water depths characterized the east, while the west was the site of a deep-water abyssal plain. Albian subsidence, in the eastern part of the ocean, coincided with tectonic uplift in the west and with the initiation of subduction along the East Asian volcanic belt.

Island arcs and trenches, formed at the end of the Cretaceous, caused oceanward migration of the subduction zones. This detached the Bering Sea and Philippine plates from the margin of the oceanic plate. Tertiary spreading along the East Pacific Rise was compensated by subduction under South America and within the deep-water trenches. Spreading in marginal seas during Oligocene-Miocene time resulted in the formation of back-arc basins, compression within the framework of island arcs and thrusting of the arcs onto the oceanic crust. Convergence of arcs may be explained by rapid oceanward displacement within marginal seas, and local movement along transform faults significantly affected the evolution of the Pacific Ocean and the distribution of mineral deposits within the oceanic basins and on the continental shelf.

BOURCIER, PHILIPPE, Energy Dept., World Bank, THONGCHAT HONGLADAROMP, Petroleum Authority of Thailand, and HAROLD M. LIAN, Union Oil Co. of California, Los Angeles, California

Thailand Gas Project—A Cooperative Effort of World Bank, Government of Thailand, and Private Enterprise

After Union Oil's discovery of large offshore reserves of gas in the early 1970s, Thailand was presented with an opportunity to reduce its almost complete dependence on oil imports for its commercial energy supplies. This, however, required considerable changes in the structure of its energy supply and the creation of a new industry in which Thailand had no previous experience. Faced with this challenge, the government of Thailand investigated several possible alternative scenarios, and associated the World Bank, which had a long experience in the power sector, the major potential gas consumer. This cooperation, involving the public sector, the international oil industry, and the international financial community resulted in one of the first successful developments of natural gas by an international oil company for the purpose of meeting the domestic demand of a developing country. The paper presents the various issues that had to be faced during the preparation and implementation of this project and elaborates on its possible value for other countries.

BOYD, GRAEME L., CSR Energy Division, Brisbane, Australia

On a Mechanism for Seam Splitting and Implications for Exploration, Evaluation, and Exploitation of Coal Resources

Exploitation of coal resources to meet both economic and community (environmental) expectations is commensurate with the scale of exploration, the comprehensiveness of data evaluation, and the "wisdom" shown in mine design. As accepted criteria, all three requirements rely on appropriate knowledge of the geology of the orebody and its associated sediments.

The Permian Coal Measures of eastern Australia are characterized by multiple seams within the measures which may coalesce or split over the entire field in a seemingly complex manner. Associated structures in the sediment pile include non-conformable attitudes of bedding, and seam displacement by low-angled overthrust faulting or bedding plane shears along stone bands.

The origin of such structures is explained by a process of differential consolidation of the primeval peat, associated with intermittent sediment influx, and capture of local drainage. Consolidation, i.e., early lithogenesis of peats, relative to the consistency of associated sediments at the perimeters of areas undergoing differential compaction provided a mechanism for lateral compression and yielding of the seam by simple shear.

The degree of splitting can be associated with variations in split quality, while associated deformations of the sediment may give rise to difficult surface and underground support conditions. Thus much information on important resource parameters is obtained from thorough analysis of exploration results which should include an interpretation of the sedimentology of the coal measure section under evaluation.

BROCHER, THOMAS M., Hawaii Inst. Geophysics, Univ. Hawaii, Honolulu, Hawaii, and **R. HOLMES**, CCOP/SOPAC Technical Secretariat, Mineral Resources Dept., Suva, Fiji

Tectonic Framework of Melanesian Borderland

We report on the initial results of a cruise to determine the tectonic framework, origin, and hence, resource potential, of the northern margin of the North Fiji basin. The cruise, coordinated by CCOP/SOPAC and manned by scientists from Australia, New Zealand, and the United States (ANZUS), was completed by the end of April 1982. The central issue is whether the Melanesian borderland is simply a remnant island arc or whether Samoan or Tuvalu Island chain volcanism was responsible, in part, for the formation of this region. During the 20-day cruise, stretching from Pago Pago, Samoa, to the western end of the Vitiaviti trench, dredge stations, piston and free-fall cores, and underway geophysical data were collected. In addition, we performed a reconnaissance of proposed spreading centers in the North Fiji basin.

BROWN, A. SUTHERLAND, and **J. GILBERT MCARTHUR**, Geol. Branch, Mineral Resources Div. Ministry of Energy, Mines & Petroleum Resources, Victoria, British Columbia, Canada

Mineral Resource Expansion in British Columbia

Starting in 1980, British Columbia embarked on a decade of major growth in its mineral industry that is based on expansion of existing mines, development of established reserves, further investigation of known prospects, and widespread grass roots exploration. Production valued at less than \$2 billion in 1980 is expected to double before the end of the decade. The evolution of the Cordillera provided a uniquely fertile environment for the formation of mineral deposits. An extensive terrace wedge on the margin of the craton and a growing collage of allochthonous terranes have been repeatedly activated by a sequence of collision, fault translation, and subduction. The result has been a great diversity of deposit types, found in a wide variety of tectonic settings from the Insular Belt to the Rocky Mountains. In the last few years it has become evident that favorable terranes for massive sulfides, porphyry, and shale-hosted lead-zinc deposits are much more extensive than originally believed. Current search

concentrates on precious metal deposits or base metal deposits with significant by-product gold and silver. An array of deposit types for the latter is now recognized, including at least four types of bulk gold-silver deposits as well as a variety of vein types. Interest in the search for strategic minerals, not previously mined in the Canadian Cordillera, is also increasing.

CARSON, CHARLES C., Sandia National Laboratories, Albuquerque, New Mexico

Geothermal Drilling Problems and Their Impact on Cost

The Circum-Pacific region is the focus for much of the current geothermal energy activity. Geothermal resources are typically accessed using conventional petroleum or water well drilling techniques. However, the uniqueness of the geothermal resource often causes problems and the impact such problems have on the costs of accessing geothermal reservoirs can be substantial.

Historical data demonstrate the significance of unexpected problems. In extreme cases, trouble costs are the largest component of well costs, or severe troubles lead to abandonment of a hole. Drilling experiences from several U.S. geothermal areas are used to analyze the frequency and severity of various problems. In addition, expected trouble costs are calculated, based on estimates of probabilities of occurrence as a function of depth for different wells.

The most frequent drilling and completion problem in geothermal wells is lost circulation. This is especially true for resources in underpressured, fractured formations. Serious loss of circulation can occur during drilling—because of this, the producing portions of many wells are drilled with air as a drilling fluid and the inherent corrosion/erosion problems are tolerated—but it can also affect the cementing of well casing. Problems in bonding casing to the formation result from many other causes as well, and are common in geothermal wells. Good bonds are essential because of the possibility of casing collapse due to thermal cycling during the life of the well. Several other problems are identified and their impacts are quantified and discussed.

CHAN, GEORGE L., Commonwealth Northern Mariana Islands, Saipan, CM

Integrated Farming System (IFS)

The Integrated Farming System (IFS) is a concept that holds promise for the people of the tropical world where there is plenty of solar energy, the nonpolluting source of power for this technologically simple system. It is a viable alternative to the highly technical and petroleum-based systems that brought economic development to the industrialized countries. The IFS approach is based on effective management of water and food systems in a complete recycling program that produces its own feed, fertilizer, and fuel for an integrated livestock-aquaculture-agriculture industry development, while controlling problems of sanitation and pollution at minimum cost and for maximum benefits.

CHAN, GEORGE L., Commonwealth Northern Mariana Islands, Saipan, CM

Role of Small Scale Biomass Systems in Alternative Development

In the thousands of islands and vast rural areas within the tropical belt of the Pacific Ocean, where the climate and natural